The Petroleum Engineer

ALL DIVISIONS

• Exploration Drilling and Production
• Refining and Gas Processing
• Oil and Gas Pipelining

AUGUST, 1950 • VOLUME XXII • NUMBER 9

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MOBILIZATION OF PETROLEUM

WHATEVER the outcome of the war in Korea, it will have a far-reaching effect on operations in the petroleum industry. Already plans are being drafted in Washington for government-industry cooperation similar in set-up to that which prevailed in the last war. A system of war priorities and controls on critical materials soon may be put into effect.

One aspect of such a system of vital concern to the industry is assurance of obtaining, and the dire need for, an adequate supply of steel for its operations. The Independent Petroleum Association of America is leaving no stone unturned to emphasize this need and to bring it to the attention of Washington. Petty, in his Washington report on page A-8 of this issue, says regarding steel that the military seems thoroughly convinced that allocating sufficient steel and other material to production, transportation, and refining is of prime importance. Firm in this belief, the military is prepared to press its demands for top priorities for all that is needed by the petroleum industry to meet war requirements.

In addition to having the support of the military on the necessity for adequate steel or petroleum operations, there is an encouraging announcement from the U. S. Steel Corporation. It has just announced that its steel-making capacity will be increased by 1,660,000 ingot tons annually through an improvement program to be instituted at the Pittsburgh and Chicago district plants of Carnegie-Illinois Steel Corporation, its principal steel-making subsidiary. This program is scheduled for completion as rapidly as possible and should increase the annual steel capacity of U. S. Steel to 1,215,000 tons within a year. The additional 445,000 tons capacity will be available by the fall of 1951.

On whether hostilities can be confined to Korea will depend the course of events in the immediate future. All indications point to our being on a war footing for a long time, and that we must be prepared for any eventuality. One ever-present danger spot is the Middle East. What happens there is the big "if" in the petroleum picture. A break-out of hostilities there would probably shut off petroleum supplies from that region. In such an event the task of supplying petroleum needs for another world war would fall on the Western Hemisphere. This is a potential sequel to the war in Korea that makes it imperative we have a vast backlog of immediately available oil reserves. To this end, and in the national interest, the industry must devote itself.—K.C.S.

Far Away Places--and Strange Sounding Names....

Petroleos Mexicanos
Mexico, D. F.

N. V. De Bataafsche Petroleum
Pernis, Holland

Royal Dutch Shell Co.
Curacao, Dutch West Indies

Asiatic Petroleum Co.
Balik Papan, Sumatra

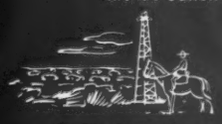
Ministerio De Obras Publicas
M. O. P. La Guaira
Caracas, Venezuela, S. A.

Behrin Petroleum Co.
Gulf of Persia

Alnorma de Maquinas
Rio de Janeiro, Brazil, S. A.

Yarur Hermanos
Santiago, Chili, S. A.

...onia Consolidada De Petroles
...cas, Venezuela, S. A.



Imperial Oil Co.
Alberta, Canada

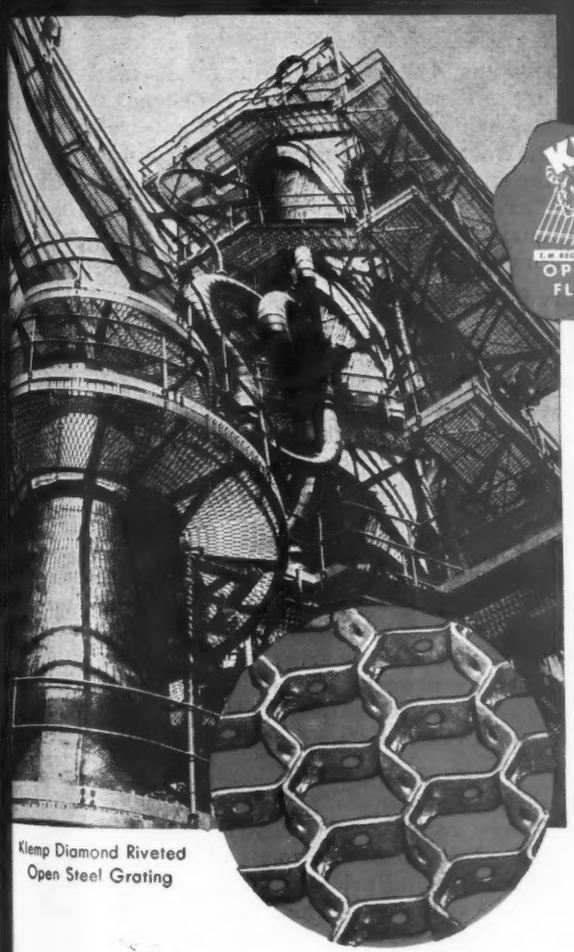
Anglo Egypt Oilfields Ltd.
Suez, Egypt

Cia Propretaria Del Central
Portugalete, Havana, Cuba

Kaohsiung Refinery
Universal Oil Products
Takao, Formosa, China

American Shoe Co.
Buenos Aires,
Argentina, S. A.

Sven Sundstrom
Gumshornsgatan,
Stockholm, Sweden



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1950

Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

A charter for another Petroleum Administration for War, providing for complete control of the petroleum industry from well to filling station, has been drafted. It will be ready for promulgation—when and if needed—as soon as Congress enacts the basic legislation for wartime controls.

First choice to head this new PAW is Ralph K. Davies who ran a similar agency throughout the last war. The staff would also be drawn from the petroleum industry.

This time, according to the plans of Secretary Chapman, all the oil controls would be administered by this one agency set up within the Interior Department.

Secretary Chapman has been successful, so far, in beating off the encroachment of other agencies. President Truman, backing up Chapman, recently wrote all interested agencies, reminding them that the job of coordinating the government's oil activities had been delegated to the Interior Department under his letter of May 3, 1946. And that policy still stands, Truman added.

Through the National Petroleum Council, the industry has endorsed the plan for another PAW, if war comes, and for continuance of the government-industry partnership, which operated so successfully in the last conflict. The NPC has recommended that the Council, as well as the Military Petroleum Advisory Board (headed by Bruce K. Brown, Pan Am-Southern), be merged into a wartime advisory agency such as Petroleum Industry War Council last time.

Meanwhile, Brown's MPAB is busy trying to solve the dilemma of supplying alkylates to the avgas plants and butylenes for synthetic rubber. It appears certain that this will require exchanges and other steps needing antitrust law clearance. So, one of the first steps will be to obtain a green light on this, either from the Department of Justice or through legislation.

▸ **Avgas.** Two ways of channeling more alkylate to the military for 100-plus octane requirements were suggested by Bruce Brown when asked for his idea. First, the "spec" for aviation gasoline used by the commercial airlines could be changed to permit 4.6 cc of tetraethyl lead instead of the present minimum of 3 cc. Second, there is something like 10,000 to 20,000 bbl daily of alkylate going into motor fuel that could be diverted to military avgas.

▸ **Octane Cut.** It seems certain that the octane ratings of high test motor fuels, whether sold as premium or regular, will have to be cut back either by government regulation or a government-sponsored voluntary agreement, if the anticipated requirements of military avgas in the next 6 months are to be met. Such a step would also tend to increase the supply of butylenes to make butadiene for synthetic rubber.

▸ **New Plants.** The "quickie" arrangements, such as trading avgas components, adopted early in the last war may suffice to meet demands of the Korean campaign. But they would be inadequate if Russia should launch World War III. And this is a dire possibility against which the military is preparing. The only answer is to construct more plants. At the close of the last war, there were 56 alkylate plants with a total capacity of 176,000 bbl a day. Today, there are between 35 and 40 alkylate plants.

▸ **Steel.** The military seems thoroughly convinced that allocating sufficient steel and other materials to production, transportation, and refining is of prime importance. They are prepared to press their demands for top priorities for all that is needed by the petroleum industry to meet war-oil demands.

Mindful of the last war's lesson, when some oil leaders thought there were plenty of wells already drilled and, as a consequence, steel supplies were grabbed up by other industries, the IPAA quickly put in a claim for the steel needed to maintain drilling, writing directly to President Truman.

▸ **East-West Line.** Already, there is a revival of talk about a "big inch" pipe line to move Texas crude to California, a project that was several times considered in the last war. With other supplies crowding the rails, there would not be much room for tank cars. Also, there is about 500,000 bbl a day of West Texas crude shut in now, much of it being sweet crude. The argument is made that such a line should be planned now and begun if the Far East hostilities expand, so there would be ample crude supply to supplement California supplies a year or so hence as needed.

▸ **Naval Reserves.** Elk Hills (California) Naval Petroleum Reserve, with between 600 and 700 wells ready to produce, probably could sustain a production of at least 75,000 bbl a day compared with a top of 65,000 bbl a day last time. Meanwhile, the talk of declaring the offshore submerged oil lands to be "naval reserves" has died down, although the military is anxious that development of these important areas be continued.

▸ **Tidelands Bill.** Senator O'Mahoney (D, Wyoming) has introduced an interim tidelands oil bill that would validate Texas and Louisiana leases issued prior to December 21, 1948, filing date of the tidelands suits against these two states. It would also make the Secretary of the Interior the "receiver" to administer all offshore submerged lands, putting payments of rentals and royalties into a special fund in the Treasury. Also, he would be empowered to issue leases with a flat 12 per cent royalty on lands in the Gulf off Texas and Louisiana for three years.

If no interim legislation is enacted, as appears to be the prospect now, Secretary Chapman may attempt to apply the Minerals Leasing Act to the offshore lands. Failing in that, Chapman believes that his only recourse then would be to contract with the present operators for continuance of operations at "cost" with balance of proceeds from the sale of this oil going into an escrow fund for future disposition by Congress.

▸ **Price Probes.** War or no war, the threat of price investigations still hangs over the oil industry. Department of Justice has advised the Idaho senators that the DJ is now making an inquiry into oil prices in the Rocky Mountain area. The DJ has "several" such investigations under way but has no objection to the Senate Judiciary Committee also making its own price study, Senator Ferguson (R, Michigan) has been advised.

▸ **Pipe Line Tariffs.** New policies for many other pipe lines may be foreshadowed by the new tariff filed by the Service Pipe Line Company (formerly Stanolind), which abolished minimum tender requirements and reduced from 8 to 5 per cent the deduction for losses in transit on natural gasoline mixed with straight crude. Some 18 other lines concurred in the tariffs filed by the Service Pipe Line, which transports for 32 refineries besides the 5 plants of Indiana Standard, its parent company.

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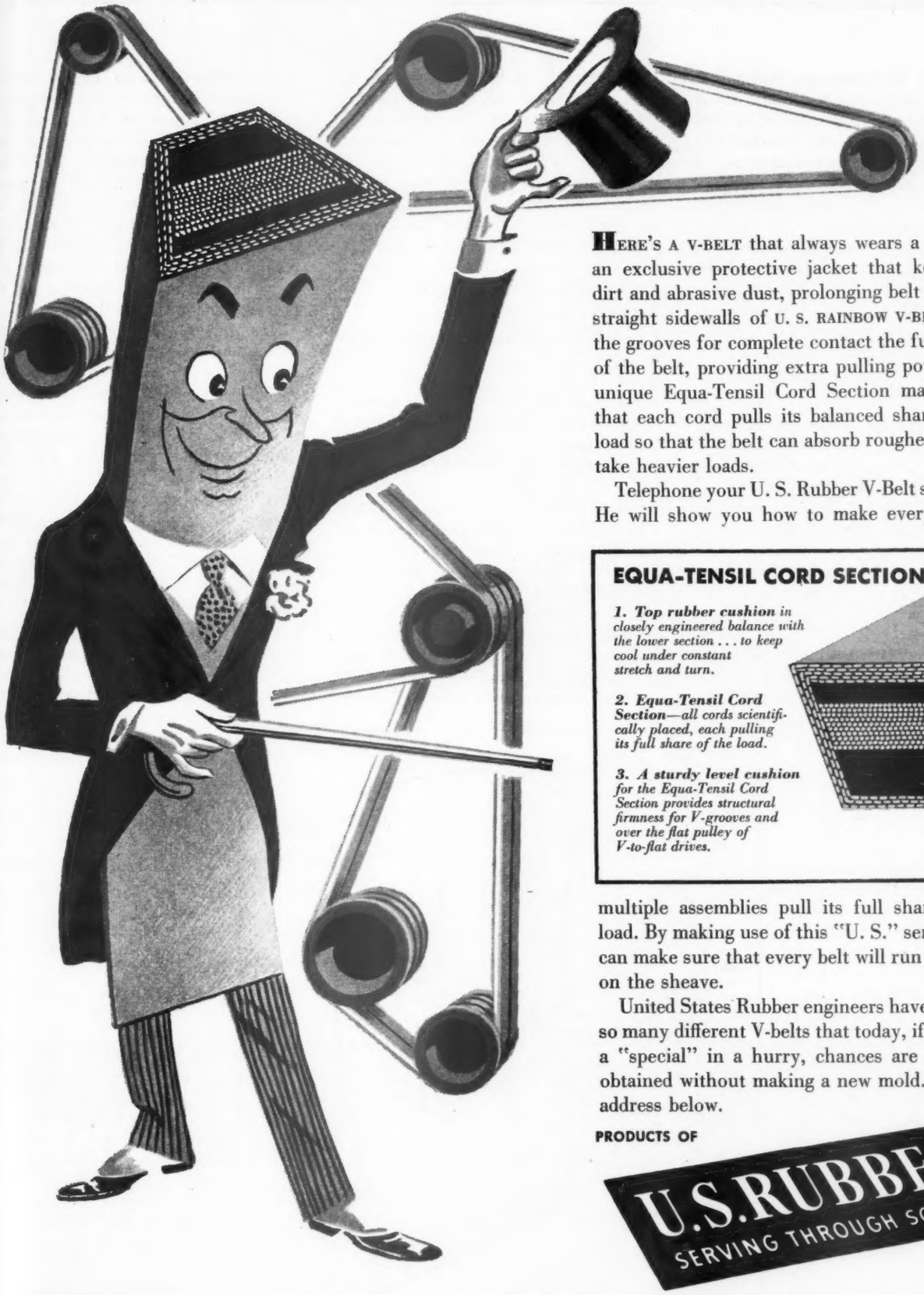

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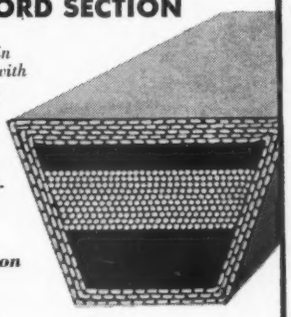

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HIGHLIGHTS IN OILDOM

▸ **No Gas Rationing.** American motorists won't have to worry about gasoline rationing—yet. Whether they will or not depends on whether the Korean war breaks out into a world conflict. That's the latest word from the API, IPAA, and the Interior Department's spokesmen.

Officials of the three agree that the American oil industry is in a position to take care of reasonable increases in demands. The Oil and Gas Division reports, "There is nothing in the picture now to indicate any current need for curtailment of domestic use of gasoline and fuel oil."

▸ **Imports Dead Issue.** Oil imports issue is dead now that the Korean war has begun. Congressman Keogh's imports committee has been dissolved and Otis H. Ellis, counsel, has resigned to resume his law practice. The recommendation for a "substantial" committee made by Senator Neely has been rejected by the Senate Labor Committee with the suggestion that the matter be referred to the Tariff Commission for study. Texas Independent Producers and Royalty Owners Association has "deferred" its fight to cut back imports, and Russell Brown (Independent Petroleum Association of America) is busy getting steel for producers, although he "hopes" importers will hold down imports.

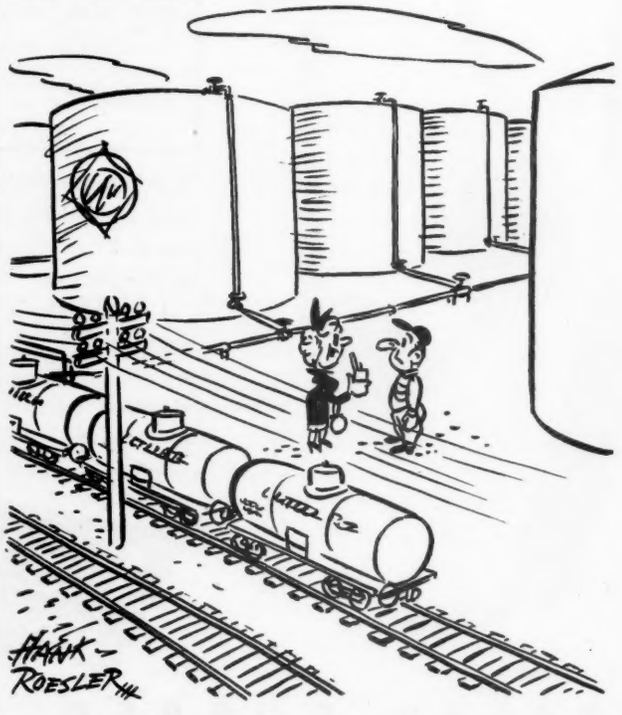
▸ **Protect Penn Oils.** The Atlantic Coast Oil Company of Glendale, Long Island, paid out $2500 recently in settlement of a suit brought by the Federal Government charging that the company had violated a Federal Trade Commission order directing it to cease false representation of its motor oils as "Pennsylvania" oil.

The government's evidence consisted of cans of oil picked up by field agents of the Pennsylvania Grade Crude Oil Association as a part of the association's regular program of sampling of all motor oils offered for sale as "Pennsylvania." Infra-red tests found them to be of non-Pennsylvania origin.

▸ **Oil Shale.** A bill authorizing the continuation of the Interior Department's program for the development of synthetic liquid fuels from coal and oil shale has been approved by an unanimous vote of the House Public Works Committee. The bill authorizes an additional $27,600,000 for the program, $2,600,000 of which must be used for construction of an experimental plant at Morgantown, West Virginia.

▸ **Depletion Allowance.** Question of a cut in depletion allowance is still being kicked around Washington, although it is considered by some as a settled issue. Treasury Secretary Snyder has again urged that the depletion allowance provided for income from oil and gas production be reduced. In his detailed analysis of the bill Snyder indicated that the Treasury Department was especially disturbed by the House action in extending the depletion allowance to industries that had not previously enjoyed such an allowance. The best assurance for increasing oil and mineral supplies is still the use of the depletion allowance to help balance risk.

The Oil Front



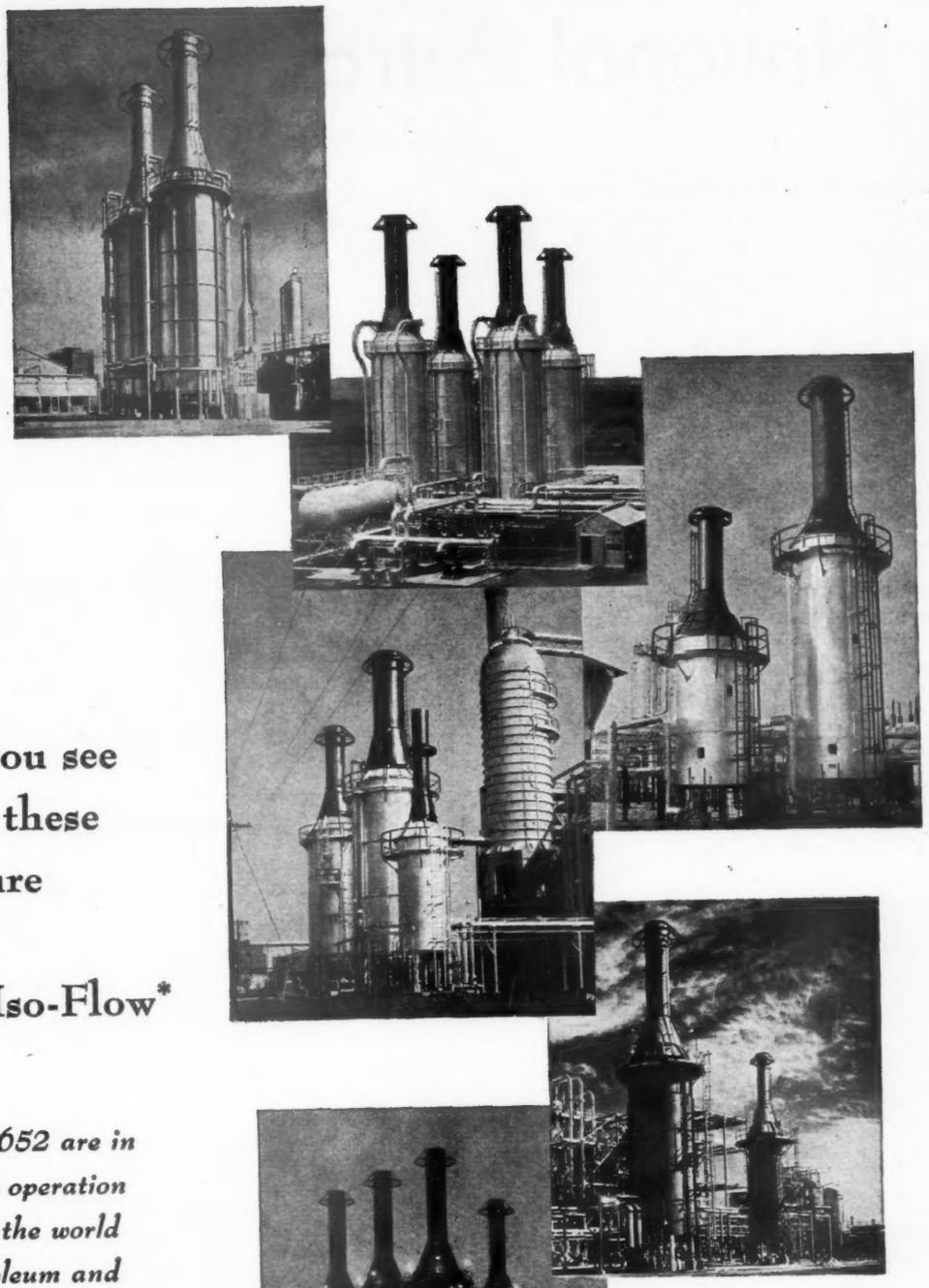
"I DON'T SUPPOSE YOU'LD MISS A TEENSY-WEENSY LIGHTER FULL"

▸ **Earnings Less in 1949.** The investment of the petroleum industry in the United States was $30.2 billion at the close of 1949, according to an estimation made by Joseph E. Pogue and Frederick G. Coqueron of the petroleum department of the Chase National Bank. The estimation was made after a study of the financial transactions of 30 major oil companies that comprise about two-thirds of the petroleum industry in the U. S.

The industry's plant, property, and equipment are carried at an estimated gross value of $23.5 billion, current assets at $6.3 billion, and other assets at $0.4 billion. Net earnings of the group were $1,408 million, a decrease of 27 per cent from 1948. The combined world-wide crude production of the 30 companies averaged 3.4 million barrels per day, a 10 per cent decrease from 1948. Capital expenditures were $2.3 billion in 1949, about 16 per cent less than was spent in 1948. Dividends were up by 19 per cent over 1948.

▸ **USSR Calls Iran Not Neighborly.** The Government has emphatically denied that plans for aerial surveys in northern part of the country are "incompatible with good neighborly relations" with Russia. The Soviet is not satisfied with Iran's answer to its note of May 14, in which she has declared that Iran was making unfriendly gestures toward Russia by allowing other oilmen to explore its boundaries. And so another note similar to the first was written.

"On the day of the publication of the last Soviet note, a U. S. spokesman announced that the Iran Government had signed a contract with an American oil firm for prospecting in northern Iran. In the circumstances, the Iranians' reply cannot be considered satisfactory." Russia went on to say that measures undertaken in the frontier region carried out with the aid of American representatives might "create a danger for the frontier of the USSR."



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National Petroleum Situation

By H. J. STRUTH*

Demand Hits New Peaks. While demand for all oils in the first half of this year was about 11 per cent above last year, reports for the first week in July indicate a new peak for gasoline demand, spurred by the four-day, July 4 weekend. With demand for products exceeding the most optimistic estimates, production allowables and refining schedules are being accelerated to a marked degree. Crude production of the nation in the week ending July 8 rose 750,000 bbl daily above a year ago, while refinery still runs were more than 700,000 bbl above a year ago.

Intense Drilling Activity. Drilling operations in June were at a high rate, with new locations and drilling wells about 5 per cent above a year ago. Completions, exclusive of input wells, in the first half of this year were 6 per cent above a year ago, with some states reporting increases of 9 to 26 per cent above last year. Wildcat operations are at a new high level of 3596 drilled in the first half, which is a gain over last year of 11 per cent. Drilling crews are extremely active in many areas, and these activities reflect the general tone of optimism which has pervaded all branches of the industry.

*Petroleum Consultant, Dallas, Texas.

Minimum Stock Levels. Stocks of crude and refined products are believed to be at minimum working levels in relationship to current and prospective demand. Stocks of all oils on June 30 were about 14 per cent below a year ago, and represented about 84 days supply, against 110 days supply a year ago. While motor fuel stocks on June 30 were at about the same level as last year, the substantially increased demand has reduced the number of days supply. Distillate fuel oil stocks on July 8 were more than 10,000,000 bbl below the level of a year ago, while residual fuel stocks were 26,000,000 bbl lower. Estimates indicate that stocks of all oils have been reduced over 59,000,000 bbl this year, compared with a stock increase last year of nearly 29,000,000 bbl.

Markets Strengthened. Market prices of crude oil and refined products have been materially strengthened by the heavy demand experienced this year, and by the prospective demand anticipated over the balance of this year. Forecasts of demand increases this year of from 5 to 5½ per cent may prove to be decidedly on the low side. Indications point to the probability that the demand increase will be more like 6½ or 7 per cent.

Comparative Statistics, June, 1950

*All figures are computed on a Bureau of Mines' Basis**

	June 1950Ⓟ	May 1950Ⓟ	June 1949	This Year to dateⓅ	Last Year to date	Per cent change
Total supply,* all oils	196,695	196,770	176,989	1,142,474	1,111,763	+ 3
Daily average	6,556	6,315	5,900	6,312	6,142	
Total demand,‡ all oils	194,213	202,154	173,340	1,201,867	1,082,795	+11
Daily average	6,474	6,521	5,778	6,640	5,982	
Change in stocks	+2,482	—5,384	+3,649	—59,393	+28,968	
Crude supply*	172,175	172,900	159,098	993,315	1,005,466	— 1
Daily average	5,739	5,577	5,303	5,488	5,555	
Crude demand‡	171,725	177,248	158,319	1,007,203	987,402	+ 2
Daily average	5,724	5,718	5,277	5,565	5,455	
Crude stocks	240,600	240,150	274,691	240,600	274,691	—12
Days supply	42	42	52	42	52	
Natural gasoline production	14,300	14,200	11,953	85,923	74,582	+15
Daily average	476	458	398	475	412	
Motor fuel production	84,600	83,250	79,383	482,039	469,863	+ 3
Daily average	2,820	2,685	2,646	2,663	2,596	
Gasoline yield per cent	44.5	44.0	45.9	43.6	43.3	+ 0.3
Motor fuel demand‡	92,070	90,184	86,866	479,276	457,824	+ 5
Daily average	3,069	2,909	2,896	2,648	2,529	
Motor fuel stocks	113,130	120,600	113,099	113,130	113,099	
Days supply	37	41	39	37	39	
Fuel oil production	61,250	63,850	54,352	381,991	381,557	
Daily average	2,041	2,060	1,812	2,110	2,108	
Fuel oil demand‡	61,400	64,659	53,287	485,630	422,733	+15
Daily average	2,046	2,086	1,777	2,683	2,336	
Fuel oil stocks	94,500	85,500	129,358	94,500	129,358	—27
Days supply	46	41	73	46	73	
Refinery still runs	168,100	169,500	154,861	977,639	964,791	+ 1
Daily average	5,603	5,468	5,162	5,401	5,330	
Stocks, all oil	545,700	543,218	634,711	545,700	634,711	—14
Days supply	84	83	110	84	110	

Current Crude Oil Prices

U. S. Average	$2.56	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.62	Mississippi	2.23
Kansas	2.62	Illinois	2.76
		Other states	2.60

Basic crude prices:

Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.80
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (26 gr.)	2.31
Pennsylvania, Bradford	3.65

Drilling and Production Statistics

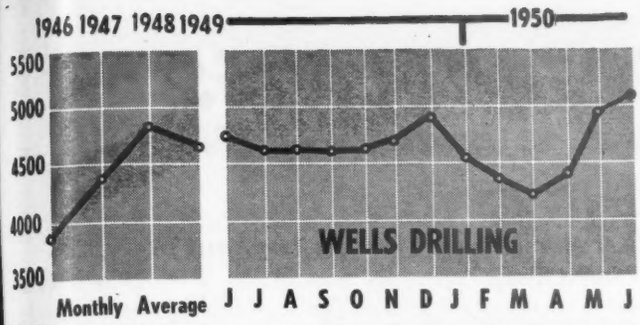
	June 1950	May 1950	June 1949	This Year to date	Last Year to date	Per cent change
Wells Drilling	5,060	4,900	4,800	5,060	4,800	+ 5
Total wells drilled	3,617	3,606	3,312	19,690	18,786	+ 5
Development wells	2,884	2,918	2,633	15,723	14,903	+ 5
Oil	1,966	1,946	1,770	10,834	10,195	+ 6
Gas	233	250	201	1,211	1,301	— 7
Dry	685	722	662	3,472	3,407	+ 2
Per cent dry	23.8	24.7	20.5	22.1	22.8	— 0.7
Service wells	50	42	72	371	643	—42
Wildcat wells	683	646	607	3,596	3,240	+11
Oil	104	106	92	546	508	+ 7
Gas	20	14	19	102	81	+26
Dry	559	526	496	2,948	2,651	+11
Per cent dry	81.8	81.4	81.7	82.0	81.8	+ 0.2

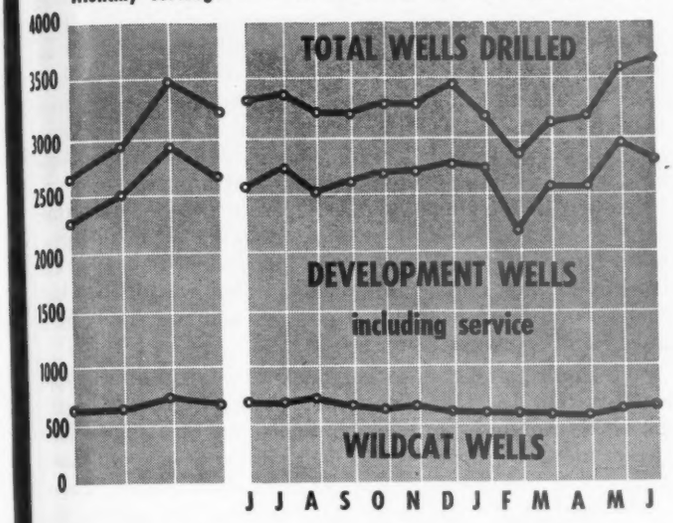
By State

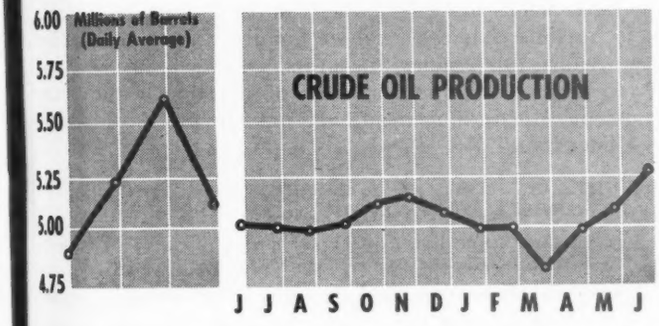
Wells drilled (excl. service)	3,567	3,564	3,240	19,319	18,143	+ 6
Arkansas	35	34	25	190	151	+26
California	148	143	242	837	1,303	—36
Illinois	286	262	259	1,211	1,113	+ 9
Kansas	313	326	269	1,730	1,499	+15
Louisiana	187	214	202	1,172	1,032	+14
Mississippi	29	29	27	167	177	— 6
New Mexico	49	49	43	318	254	+25
Oklahoma	465	461	385	2,534	2,011	+26
Texas	1,383	1,381	1,207	7,873	7,031	+12
Other states	672	665	581	3,287	3,572	— 8
Wildcats drilled	683	646	607	3,596	3,240	+11
Arkansas	12	9	4	52	26	+100
California	28	38	53	184	255	—28
Illinois	65	57	42	300	190	+58
Kansas	69	75	49	333	242	+38
Louisiana	17	19	32	128	158	—19
Mississippi	10	12	10	69	54	+28
New Mexico	4	8	6	38	41	— 7
Oklahoma	73	76	71	418	366	+14
Texas	265	253	253	1,534	1,479	+ 4
Other states	140	99	87	540	429	+26
Daily crude production	5,256	5,077	4,903	5,003	5,144	— 3
Arkansas	87	86	78	88	84	+ 5
California	866	852	921	862	937	— 8
Illinois	167	170	179	173	174	— 1
Kansas	279	280	276	273	288	— 5
Louisiana	586	550	514	553	521	+ 6
Mississippi	107	101	100	100	108	— 7
New Mexico	126	126	134	128	133	— 4
Oklahoma	418	407	405	419	420	
Texas	2,300	2,140	1,915	2,051	2,102	— 2
Wyoming	155	156	130	157	125	+26
Other states	165	209	251	199	252	—21

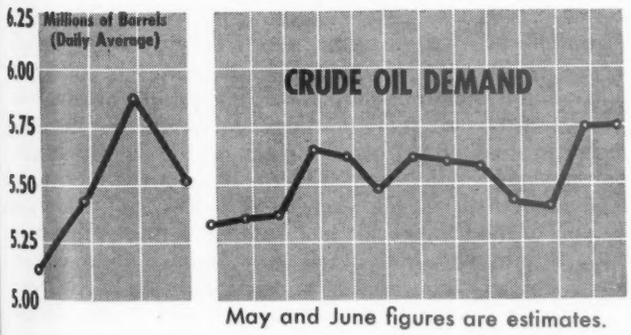
* Unless otherwise stated all figures represent thousands of barrels. ‡ Total demand, including exports. * Includes domestic production and imports. Ⓟ—Preliminary.

Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.

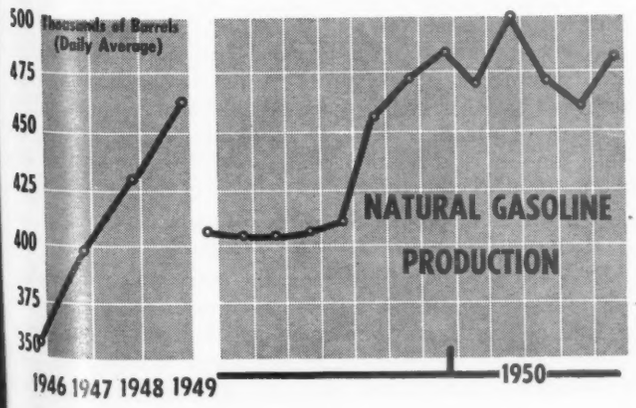


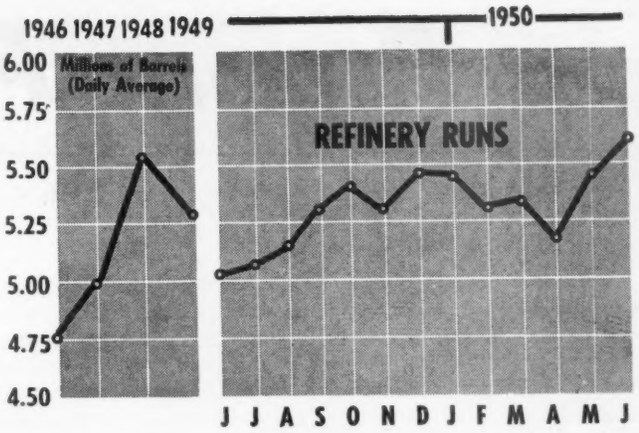


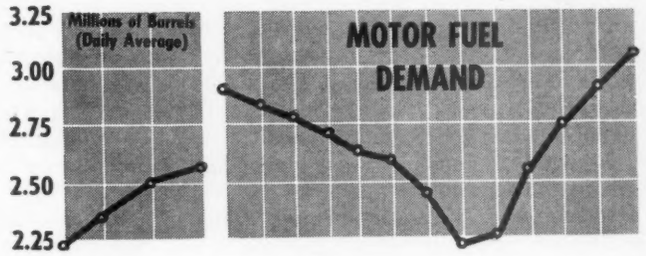


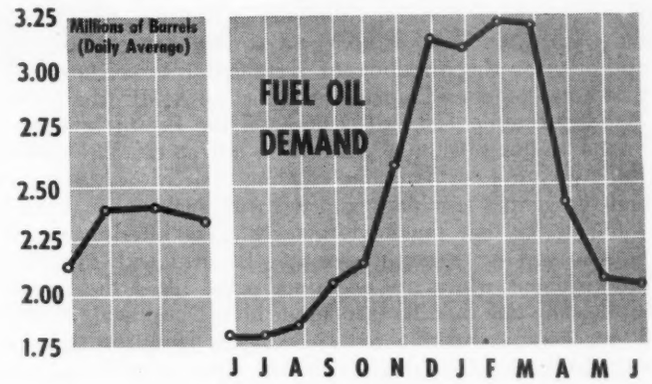


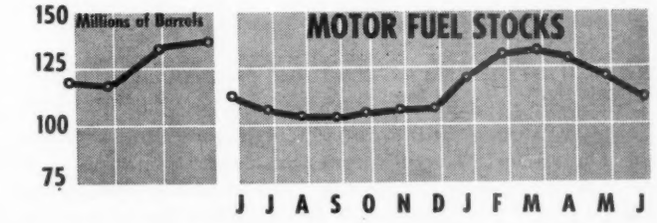
May and June figures are estimates.

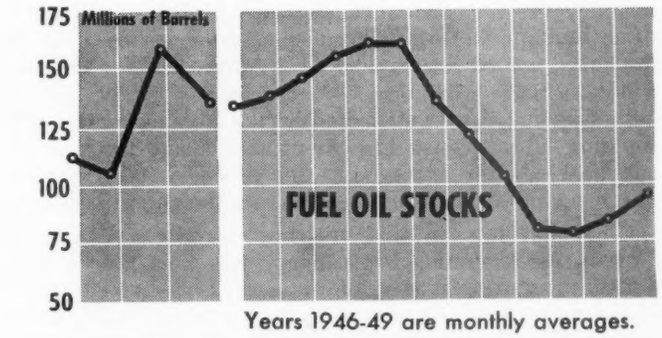




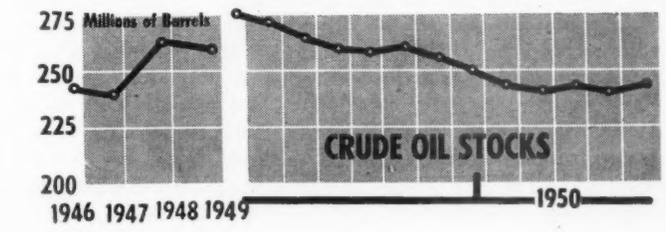








Years 1946-49 are monthly averages.



PETROLIC PERSONALITIES

DICK SNEDDON

Power Model Makes Good

A recent dropper inner at the Los Angeles Petroleum Club was that amiable and very distinguished looking educator from the University of Texas, H. H. "Harry" Power, chairman of the engineering department, and by all accounts one of the finest cerebrum titilaters ever to snap a budding Einstein out of a lecture hall nap. It has been suggested that the Power system of mental improvement is very similar to the manufacture of coffee, in that it seeks as far as possible to employ to the very best purpose the active ingredient of the bean. That the modus is more than successful is proved by the countless Power models who are now expertly juggling dynes, poises, and millidarcys for fairish emolument in every near and remote corner of the vast petrolic empire.

Incidentally, we might mention that one of the learned professor's erstwhile charges, to wit, J. W. "Winnie" Winfrey, supervisor in the petroleum engineering division of Humble Oil and Refining Company at Houston, has become nationally famous as a caller of square dances. His rare aptitude for the direction of rectangular terpsichore was first noted by one of our operatives at an AIME whangaroo in San Antonio last fall, where on the list of scheduled events was a session of allemande left at the La Vallita. Here Winnie had the ladies crossing their lily white hands and the gents their black and tan with such unusual grace and celerity that the hayloft sages were utterly amazed. So also was Professor Power who listened with profound astonishment while his one time pupil lilted the figures in the song-talk that the farmhands love. Upon being twitted by several bystanders about the Winfrey facility with barnyard badinage, the Professor denied vigorously that square dance calling had ever had a place on his college curricula.

Fort Worth Devastated by Nomad Golfers

We hear exciting reports next of a great to do at The Colonial Country Club in Fort Worth some time ago, when the Dallas-Fort Worth chapter of Nomads staged a golf tournament and barbecue that was what the literati ordinarily term "a lalapaloosa." It happened that a few days prior to this august convocation the club was the scene of an Invitational Golf Tournament, which was by a virtual unknown, named Sneed, who never worked in any oil field while we were there. Anyway, we can say on the best of authority that the divots raised by the Nomads were much superior to those hoisted by the professionals—much larger and heavier—and the boys really gave old terra firma a nasty tossing about, without damaging their golf balls.

Chief factotum in this vigorous exercise was George Stevens, the Cummins Diesel chap from Fort Worth, who not only acted as starter for the excavators but later presented prizes to those who were successful in finding their way back to the clubhouse. Following an excellent dinner of charcoal broiled steaks, during which a pair of comely young ladies, one with an accordion and the other with a voice, stimualted staccato outbreaks of song. Ken Davis of Mid-Continent Supply officiated as Fort Worth host, while A. J. "Ole" Olsen, chapter prexy, gave him valuable aid in suppressing over-exercise of the four freedoms, and Ed Whetzle of Drilling peppered the lads out front with a liberal barrage of witty bits.

Piscatorial Rival Builds Lookout Station

Our Chicago operative now brings a choice morsel of gossip relating to one Stan Martin, a highly respected member of the crude purchasing department of Roosevelt Oil and Refining Company at Mt. Pleasant, Michigan. It appears that between rustling the black stuff in Tulsa, Houston, Philadelphia, and other oil centers, and expostulating to all and sundry about the shortage of it, our friend finds time to hie himself out to his summer home on the banks of Lake Houghton. There he takes his fishing rod and reel, sits down in a secluded spot, and presently the comforting nibble of a lake trout or even the hooking of an old shoe, takes him completely away from his business worries, and transports him into an oil man's dream world, in which there is unlimited crude oil at no cost, and everybody has a lovely time—but the fish.

We don't want this to get back to Stan, but we learn reliably that Jack Boudler, prexy of the Roosevelt organization, is quietly building a summer home on Higgins Lake —not too far from Lake Houghton—and has purchased high power binoculars so that he can keep his eyes on Stan, and thus confirm or refute the startling fish stories that the latter keeps bringing back from his lacustrine hideout. It is possible that the Boulder bungalow may be finished even before this reaches the press, in which case we shall try to pick up some reports from observation headquarters about the Martin movements and disclose the sordid details in a later issue.

The Joneses Do Europe

Comes now some brief excerpts from the diary of Elberta and Wendell Jones, that is, the Bethlehem Supply Company Joneses, who have just recently returned from an extended visit in Europe that they both obviously enjoyed beyond words. It is easy to understand how the Joneses would have a good time wherever they went. They are people who literally brim over with all the qualities that make for human understanding and good fellowship—always considerate of the well being of others and completely absorbed in the process of getting the most out of life by helping their friends do the same. Elberta is an artist who found a genuine thrill in the variegated scenes and intriguing customs of the Old World; and Wendell is one of those perfectly uninhibited individuals who, knowing no conventional barriers, ingratiates himself with Lady Bearsted, and is later invited to her ancestral home, Upton House, for a chat and cocktails with Her Ladyship; hobnobs with the brother-in-law of Newell Baker, British minister of fuel and power, with whom he became acquainted at a Rotary Club meeting in Paris; dines at the Royal Empire Club, one of London's most exclusive hostelries; and, indeed, visits more places and meets more dignitaries during the short time he is in London, than do most of the people who live there all their lives.

A Warm Welcome to The Hague

Here are a couple of bits from the diary concerning some well-known Americans, Elberta writing first: "When we arrived at the Hague our room was full of flowers from Hellen and Wally Gilbert and Gladys and Al Baptie, with an invitation to dinner and 'Welcome to Holland!' inscribed

"When an engine drops off in power, it pays to investigate and correct the trouble immediately.

"Often, a relatively simple adjustment like altering injection timing, changing valve lash, or replacing a faulty injector will do the trick. At other times, loss of power may be the sign of a more serious condition such as loss of compression through the gap openings of the piston rings.

"Compression loss—or blow-by—is serious because it is difficult to detect at its start, yet it grows progressively worse as ring and cylinder wear is accelerated by the erosive action of hot gases blasting through the gaps.

"Whatever the cause, when Cook engineers are called in to make ring recommendations, they check all such factors and suggest corrective measures where needed. Then, when all variables have been 'zeroed out' the rings are job-engineered to your specific operating and engine conditions.

"If blow-by is your problem, for instance, Cook engineers will probably recommend the installation of COOKTITE Sealing Rings. These rings are, in effect, gapless rings and provide a positive and dependable seal of compression pressures even in badly worn cylinders. In fact, their use in many engines has stepped up horsepower, cut fuel bills and has materially improved engine availability."

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PISTON RINGS

. . . SEALING PRESSURES SINCE 1888 . . .

in Dutch—and the Netherlands whirl had begun. Wally called for us in an automobile and detoured by the country club. The first night we had dinner at the Gilberts, and enroute Wally taugh me to say what sounds like 'Hail moi vier nek var,' or 'Your weather is fine.' I got it out well enough for Gladys and Al Baptie to understand me, so with good weather, grand friends knocking themselves out for us, and 'Welcome to Holland!' in print everywhere and said to us by all attendants from the minute we stepped off the train, we fell in love with the Netherlands."

On the same subject, Wendell writes, "The Bapties and Gilberts devoted two full days to us, with private car trips, meals in wonderful places, and even 18 holes of golf in the rain on the toughest course in Europe. We were fortunate in being there (The Hague) on Saturday and Sunday, as we were able to visit important offices of the Royal Dutch Shell, or N. V. de Bataafsche Petroleum Maatschappij, particularly Mr. Bloomgarden's—with him we also enjoyed a nice visit at the Club—, and were able to make a leisurely inspection of the grounds. The Company is this year celebrating its 60th anniversary, and has set up a large display depicting its history and growth. It is evident that our American friends are enjoying their work and living conditions in Holland. Both have important positions, live comfortably, have ample help, and are devoting much of their time and energy to learning Dutch and becoming familiar with the country, so that they make excellent guides and hosts."

Saxophonist Hits the Big Time

Another bit of news of a transplanted American, taken from the joint opus of the Joneses, concerns our old Wilmington, California, buddy, Norval Myers. It was contributed by Wendell, and is as follows: "I took my friend Norval Myers to the London Rotary meeting on Tuesday. Norval is a director of the Anglo-American Oil Company. He is a very able scientific refiner, occupied in administrative and directive work, and is getting a tremendous thrill out of his very important assignment. His wife, Ted Miles' sister, and their two boys will join Norval in a few days. The boys will return to Harvard and Dartmouth in the fall. The Lord Mayor of the borough in which he has taken up residence sat across the table from us—a good contact for Norval."

We were pleased no end to have this encouraging word of Norval, upon whose predilection for English tobaccos we have already dilated somewhat in this column. The well-known saxophonist and Anglo-tobaccophile (Whoops, my dear!) is apparently quite at his ease over yonder on Picadilly, Rotten Row, and the Strand, and we wouldn't be surprised to learn anytime that he and Winnie Churchill are thicker than six gravity oil. Concluding this section of the monthly disappointment, we might say that the diary is a very illuminating account of an interesting journey by two very observing individuals. Space limitations, of course, confine us to those few sections that treat of oil people, but lift out of well told travel tales.

Golfers Blinded by Luminescent Shirt

A couple of Fridays ago with several hundred other pleasure bent oil men we wended our untroubled way out to the Lakewood Country Club at Long Beach, where the Los Angeles chapter of Nomads was holding a species of wassail known as a whing ding. The affair was pretty much under the wing of Jerry Engstrand, the good looking Grant Oil Tool chap, who is sergeant-at-arms for the chapter, and we will say unreservedly that Jerry did himself proud.

The festivities started off with a golf tournament under the direction of Bill Wilson, Joe Schlarb, and George Gudenkunst, and the sward has never been so unmercifully lashed since the abandonment of the flail. Even the peacocks screamed in prolonged, baby-like protest, but that may have been because they were frightened by Bill Wilson's luminescent shirt. Bill has now definitely displaced George Trembley as owner of the industry's most conspicuous shirt. He appeared at this fracas in a dazzling yellow creation that caused more eyestrain than Lady Godiva. The gaming was in charge of Ray Humphreys and Bill Sargent and they did such an outstanding job of counting out the chips that they have since been offered permanent berths in Monaco.

Oil Men from Foreign Fields

Johnny Flanagan, the M. O. Johnston rep, was unable to play golf because of a bad tempered sacroiliac, but he was able to do his usual excellent job of hosting the foreign guests. At different times during the day we saw him with Arnett Norcott, retired manager of International Petroleum in Peru, also at one time with Tropical Oil in Colombia; Lionel Wiedey, present manager of Tropical; Dutch Slaughter, drilling superintendent of Tropical; Walt Little, retired drilling superintendent for Tropical; and Lee Chisholm, former assistant drilling superintendent for Tropical. These foreign territory vips all came down to the whing ding to celebrate Bob Block's departure for Alaska. Bob is a former drilling superintendent for International and was also with Tropical. He left shortly after the meeting for Point Barrow, where he will assume the chores recently vacated by Swede Larsen.

Other visitors from foreign lands, spotted under the Flanagan aegis were Ed Coenen, Standard Vacuum field superintendent from Sumatra, in the process of being transferred to New York; Slim Tidwell, head driller for Iraq Petroleum; Shorty Bowen, on vacation from Shell in Colombia; Tom Murray, camp boss for 20 years for International in Peru, now living retired in Fullerton, California; and W. N. Thompson, toolpusher for Texas in Colombia.

Apologia!

We omitted last month to apologize, as we had intended to, for transplanting Bill Texter from Youngstown, Ohio, to Chicago, Illinois, without due authority. The basic information for the paragraph that appeared in Petrolic Personalities for June came from our operative in Chicago, and we just stupidly assumed that so did Bill. The result of this blunder is that the entire population of Ohio is screaming for our scalp, while Chicago is simply tickled silly. Confidentially, our scalp wouldn't be much good to Ohio—it has practically nothing on it, and what lies underneath is as placid and unproductive as cold porridge. We are, however, pleased to make it known now that Bill is a faithful and trusted citizen of Youngstown, Ohio, and that the jubilation over his expert dude ranching took place in that lively bailiwick, and not in the Windy City as we reported. Our sincere regrets, Bill, and we'll never do it again!

Last Minute Briefs

By way of last minute roundup, as we write, the Deckers are still breezing around Europe and enjoying themselves to the full. Jimmy West, former lands and leasing biggie for Richfield Oil Corporation, has set up in business for himself in Los Angeles. Larry Kelley, the Houstonian scion of Grover Kelley was out on the coast for a brief sojourn. Herb Reed, the Standard Oiler is rapidly rising to the top echelons of the gin rummy set. Bill Geis is to be the next speaker for the Desk and Derrick Club at Los Angeles. Booth Strange of Natches, Mississippi, has been appointed a vice president of Western Geophysical Company of America. And last but by no means least, the Government is now definitely in competition with the petroleum industry, having become expert in the manufacture of a product named Turm-oil!

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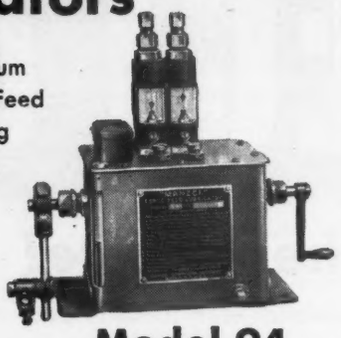

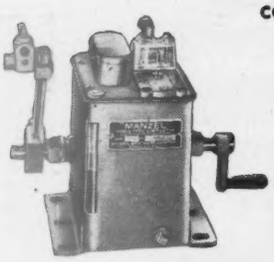

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Double Plunger Type. One to thirty feeds. Each feed adjustable, from fraction of a drop to 13 drops per stroke.

Model 94

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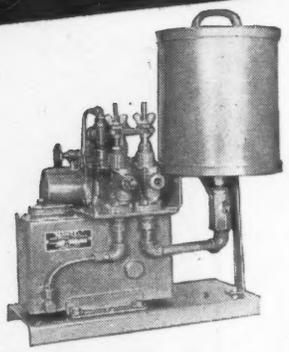

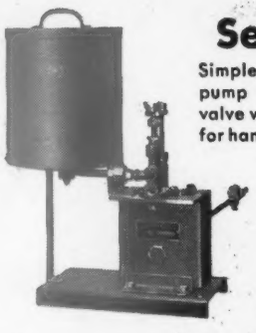

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MEETINGS

☆ ☆ ☆

Aug. 30-Sept. 1 — Tenth Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, West Virginia.

Sept. 3-8 — American Chemical Society, Chicago, Illinois.

Sept. 5-9—National Chemical Exposition, Chicago Section, American Chemical Soc., Coliseum, Chicago, Ill.

Sept. 10-13—The American Institute of Chemical Engineers Regional Meeting, Radisson Hotel, Minneapolis, Minnesota.

Sept. 11-13—International Discussion, Postwar Heat Transfer Development, London, England. Participants from North America include: AIChE, ACS, AIME, ASME, etc.

Sept. 11-13—Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 11-15—ASME Industrial Instruments and Regulators Conference with the Instrument Society of America, Municipal Auditorium, Buffalo, New York.

Sept. 13-15—National Petroleum Assn, Hotel Traymore, Atlantic City, N. J.

September 14.—American Petroleum Institute, Lubrication Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 14-15—Midwest Gas Assn, Gas School and Conference, Ames, Iowa.

Sept. 18-19—National Butane-Propane Assn, Annual Convention, Hollenden Hotel, Cleveland, Ohio.

Sept. 18-22—Instrument Conference and Exhibit, Instrument Society of America, Memorial Auditorium, Buffalo, New York.

Sept. 24-28—ASME, Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.

Oct. 1-3 — IPAA, Annual Meeting, Jefferson Hotel, St. Louis, Mo.

Oct. 2-6 — AGA, Annual Convention, Atlantic City, New Jersey.

Oct. 4-5—Mid-Continent Oil and Gas Assn, Texas Division, Baker Hotel (tentative), Dallas, Texas.

Oct. 4-6—AIME, Petroleum Branch, Fall Mid-Continent Meeting, Roosevelt Hotel, New Orleans, La.

Oct. 5-6—Liquefied Petroleum Gas Assn, North Eastern district meeting, Ambassador Hotel, Atlantic City, N. J.

Oct. 9-10—American Assn of Oilwell Drilling Contractors; Annual Meeting, The Mayo, Tulsa, Okla.

Oct. 12-13—AIME, Petroleum Branch, Fall West Coast Meeting, Elks Club, Los Angeles, Calif.

Oct. 15-21—Oil Progress Week.

Oct. 16-20—National Safety Congress, Chicago, Ill.

Oct. 19-20—American Assn of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, and Society of Exploration Geophysicists, all Pacific Coast Sections, Ambassador Hotel, Los Angeles, Calif.

Oct. 19-22—Permian Basin Oil Show, Odessa, Texas.

Oct. 23.—Independent Natural Gas Association of America, Annual Meeting, Shamrock Hotel, Houston, Texas.

Oct. 23-27—AIEE, Fall General Meeting, Skirvin Hotel and Skirvin Tower Hotel, Oklahoma City, Okla.

Oct. 23-27—National Metal Exposition, Amphitheater, Chicago, Ill.

Oct. 27—Natural Gasoline Association of America, Southern Regional Meeting, Blackstone Hotel, Tyler, Texas.

Oct. 30-Nov. 1—National Lubricating Grease Institute, Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

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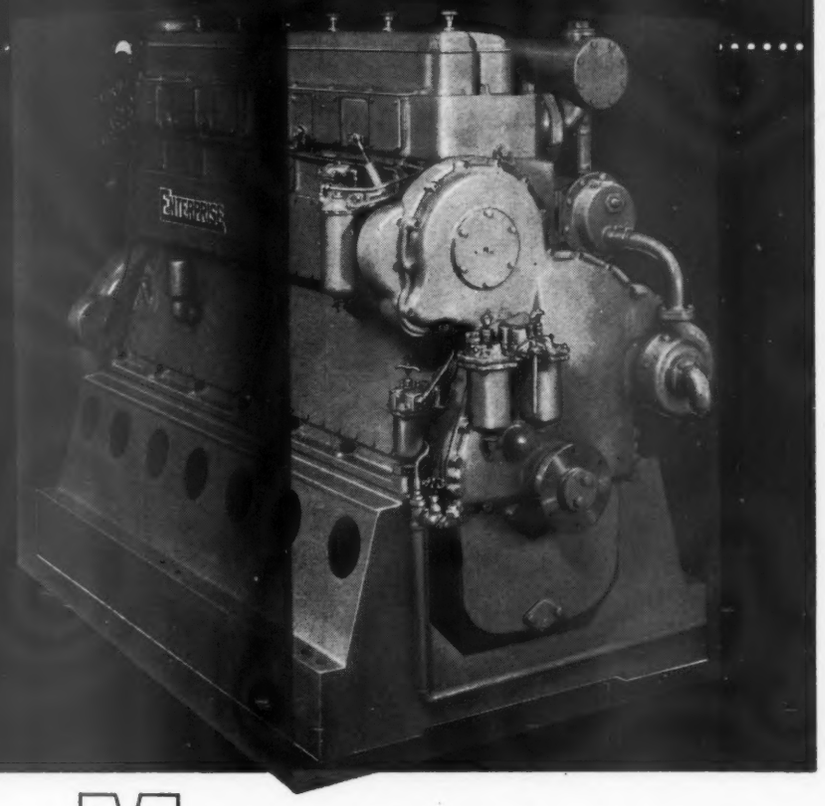

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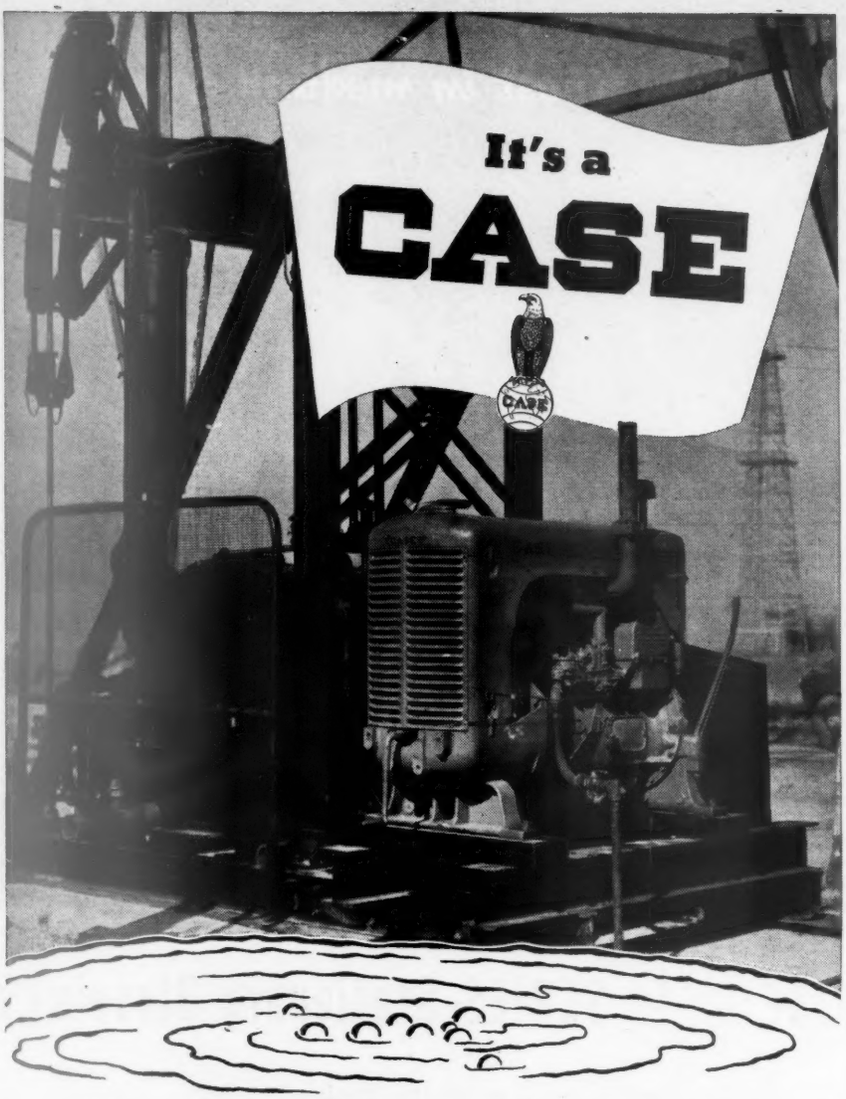

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Nov.—Mid-Continent Oil and Gas Assn, Mississippi-Alabama Division, Edwards Hotel (tentative), Jackson, Miss.

Nov.—Mid-Continent Oil and Gas Assn, Kansas-Oklahoma Division, Tulsa Club (tentative), Tulsa, Okla.

Nov. 2-3—Mid Continent Oil and Gas Association, Louisiana-Arkansas Division, Roosevelt Hotel, New Orleans, La.

Nov. 2-3—Society of Automotive Engineers, Diesel Engine Meeting, Hotel Knickerbocker, Chicago, Ill.

Nov. 9-10—SAE, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

Nov. 10—California Natural Gasoline Assn, Annual Meeting, Ambassador Hotel, Los Angeles, Calif.

Nov. 11-13—Oil Industry Information Committee, Biltmore Hotel, Los Angeles, Calif.

Nov. 13-14—American Petroleum Institute, Lubrication Committee, Biltmore Hotel, Los Angeles, Calif.

Nov. 13-16—API, Annual Meeting, Biltmore Hotel and Ambassador Hotel, Los Angeles, Calif.

Nov. 26-Dec. 1—ASME, Hotel Statler, New York, N. Y.

Dec. 3-6—AIChE, Annual Meeting, Columbus, Ohio.

1951

March 7-9—American Petroleum Institute, Division of Production, Southwestern District Meeting, Hotel Beaumont, Beaumont, Texas.

March 16-18—American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Bellevue-Stratford Hotel, Philadelphia, Pa.

March 23-25—Southern Gas Assn, Buena Vista and Edgewater Gulf Hotels, Biloxi, Miss.

Apr. 2-4—Western Petroleum Refiners Association, Annual Meeting, Plaza Hotel, San Antonio, Texas.

Apr. 18-20—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.

April 30-May 3—American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa, Okla.

May 13-16—AIChE, Regional Meeting, Hotel Muehlebach, Kansas City, Mo.

May 28-June 6—World Petroleum Congress, The Netherlands, The Hague.

June 16-20—Canadian Gas Assn, Bigwin Inn, Lake of Bays, Ontario, Canada.

Oct. 14-20—Oil Progress Week.

Nov. 5-8—API, Annual Meeting, Stevens-Palmer House, Chicago, Ill.

Dec. 2-5—AIChE, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Sec. Russ V. McIntire, 11 West 42nd Street, New York 18, New York.

Houston Chapter, Second Monday of The Month, Ye Ole College Inn, Houston, Texas. Sec. Harry E. Estes, P. O. Box 9321, Houston 11, Texas.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Sec. John W. Rife, 5905 Pacific Blvd., Huntington Park, Calif.

Tulsa Chapter, Third Wednesday of the Month, Hotel Tulsa, Tulsa, Okla. Sec. G. W. Davidson, Jr., Box 1188, Tulsa, Okla.

Dallas Chapter, Dallas, Texas, Second Monday of September. Sec. C. J. Berlin, P. O. Box 2968, Dallas, Texas.

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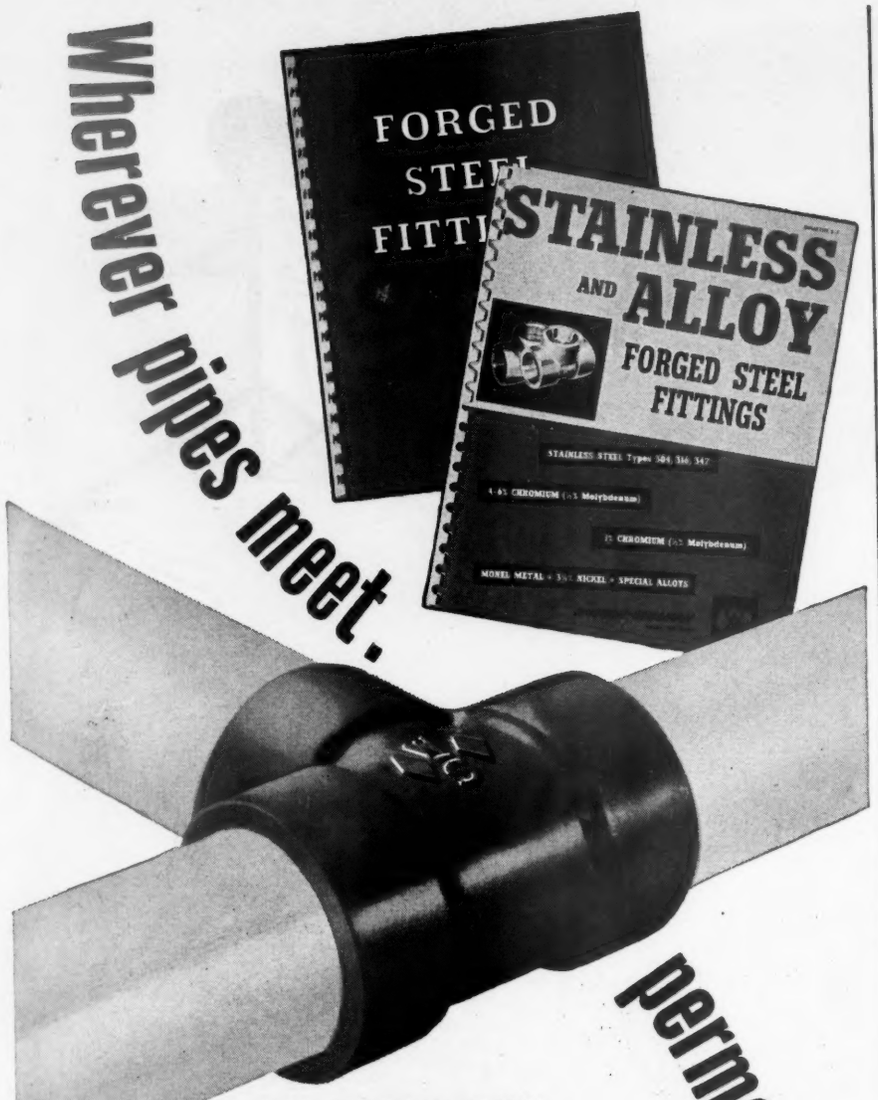

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LETTERS
to the Editors

Pig vs Go-Devil

To The Petroleum Engineer:

Dear Mr. Love:

We were much interested in an article and illlustration contained in your May, 1950, issue of *The Petroleum Engineer* on page D-32. We recognized this as a picture of a Williamson Pipe Line Pig as used by the Southern Counties Gas Company (your article refers erroneously to the Southern California Gas Company). We were greatly disappointed however that you used the term "Go-Devil" for this tool and referred to it as such several times in the article. This of course is not a Go-Devil nor does it resemble one, but is a Williamson Pipe Line Pig.

T. D. Williamson
T. D. Williamson, Inc.
Tulsa, Oklahoma.

Mast Article

To The Petroleum Engineer:

There is a fine article in the June, 1950, issue of *The Petroleum Engineer* on the use of wide clearances in compressor cylinders written by Mr. B. T. Mast.

The writer would like to have six reprints of this article. Will you please tell the writer the cost of these six reprints and he will mail you a money order or check to cover these costs.

Drew Whiting
Ingersoll-Rand Company

Bouquet

To The Petroleum Engineer:

We have been receiving the various editions of your publication and have enjoyed the many new editorial features and departments which have been added.

C. L. Crenshaw
Vice President,
Shallowater Refining Company
Kansas City, Missouri

The best pay that I ever got was experience, which I think is still the most valuable thing in the world. It is the one thing no one can take away from me.
—Henry Ford.

THE Petroleum Engineer

Volume XXII No. 9
AUGUST, 1950

Looking Ahead at Alberta Oil and Gas

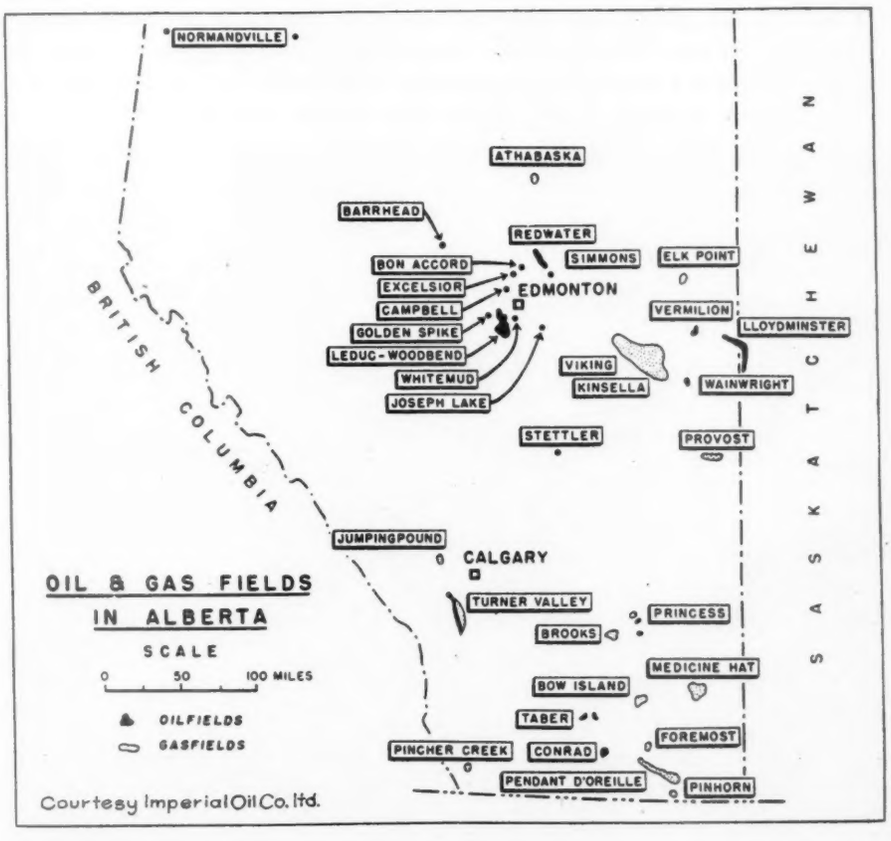
The Lucky Province Can Soon Produce and Distribute Petroleum and Products to the Whole Canadian Dominion—Some $300,000,000 Is Going Into Exploration and Development and a Great Pipe Line for Better Transportation Will Be Completed Next Spring.

H. G. COCHRANE

RECURRING coal strikes, replacement of railway locomotives by diesel units, widespread industrial expansion, and general prosperity are probably all reasons for the recent sharp increases in Canada's per capita petroleum consumption. This has risen 77 per cent over a decade, compared with 57 per cent in the United States. Alberta's Conservation Board regulations, the $300 millions being spent this year on oil exploration and development, and promise of an early outlet to the Ontario market, offer possibilities for a growing percentage of Canada's oil consumption being met from domestic sources, almost entirely from Alberta.

Since the first discovery at Leduc in February 1947, soon followed by strikes at Redwater, Golden Spike, Pincher Creek, Stettler, Joseph Lake, Excelsior, and most recently at Normandville and Whitelaw in the Peace River district, Alberta reserves have been mounting steadily, and today are estimated at more than a billion barrels. New wells are being drilled at an average rate of some 75 monthly. Most are development wells in proved areas, which accounts for more than two-thirds of them being successful.

Today there are more than 100 geophysical parties spread over the prairie provinces, and in Alberta alone the rate of prospecting is exceeded only by the state of Texas. More than 100 Canadian and U.S. oil companies are represented. Alberta Government regulations under which exploration is carried out, not only encourage but demand rapid development. The Province, which owns more than 90 per cent of all mineral rights, grants reservations to exploring companies that may be held three years under certain conditions before they are converted to leases. Small rentals are charged, and by the third year drilling has to commence.



EXCLUSIVE

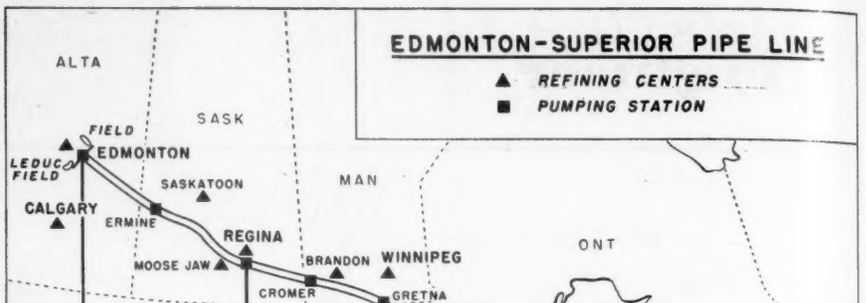
When oil is discovered, the explorer must within three months select and lease half the acreage in the block, and give up the balance, which may then be put up for auction by the Province. Purchasers of rights under such lands must commence drilling within 12 months. Besides this, the owner of proved acreage must drill offsets to keep wells on adjoining property from draining away some of his oil. Thus, there are tremendous incentives for drilling to continue at an ever increasing rate, even though an adequate market for all the oil is not in sight.

Constructing Pipe Line to Eastern Markets

Early last year Imperial Oil, leader in the industry, sponsored plans for a pipe line from Edmonton to serve Regina refineries. By September, recognizing that further markets had to be tapped, they announced extension of the pipe line to Superior, Wisconsin, incorporated as a common carrier, with initial capacity of 95,000 bbls daily to Regina and 70,000 from Regina.

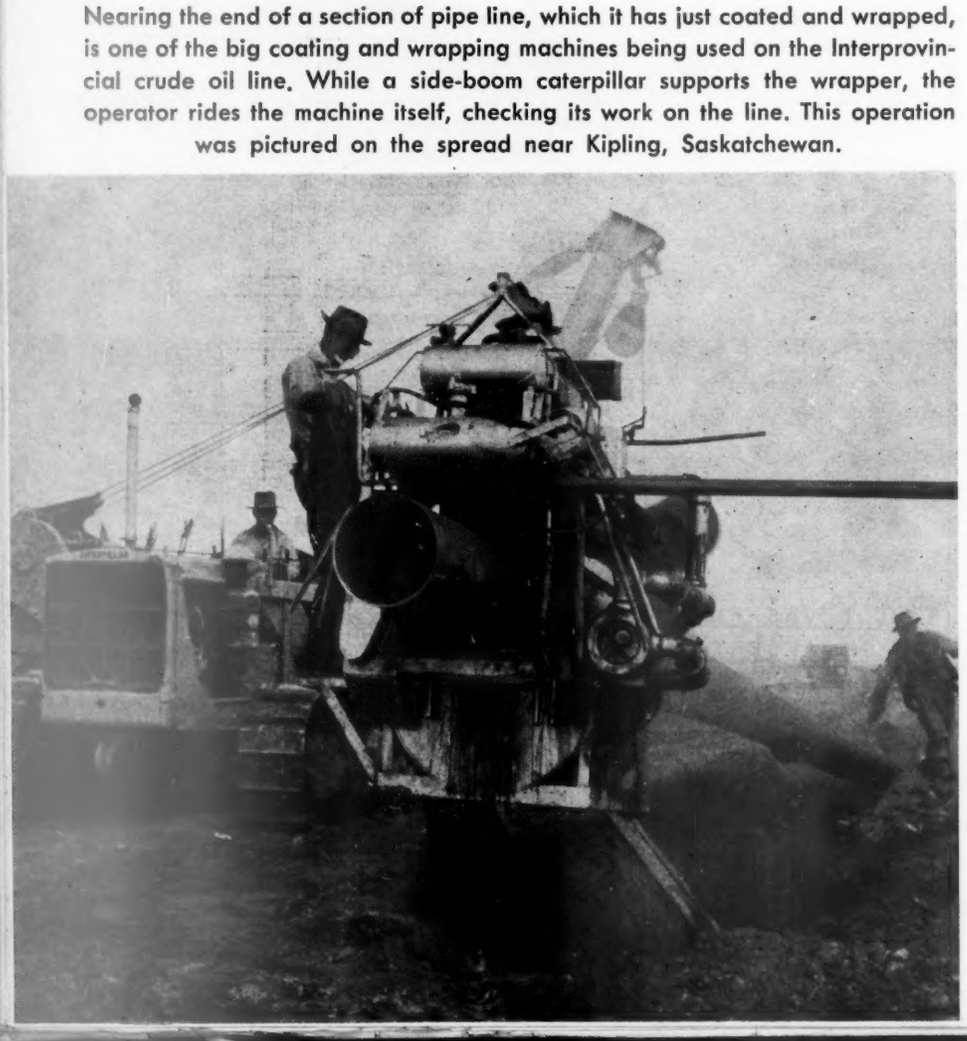
Progress on laying this common carrier, known as the Interprovincial Pipe Line, is proceeding at a rate of more than 9 miles a day in favorable weather. Eight construction spreads are racing to get the 1180 miles of line in the ground by late fall of this year.

Additional pumping stations will later increase these capacities (above) by about 50 per cent. The pipe is expected to be in operation as far as Regina during the coming fall, while oil is expected to reach Superior, Wisconsin, by the end of the year or soon thereafter. Here vast storage tanks of 1.8 million bbl capacity will store reduced winter throughput to feed lake tankers during the navigation season with bonded oil, to supply Sarnia and Toronto refineries eventually with 70,000 to 100,000 bbl daily, replacing imported oil from U.S. fields.



Courtesy Imperial Oil Co. Ltd.

Nearing the end of a section of pipe line, which it has just coated and wrapped, is one of the big coating and wrapping machines being used on the Interprovincial crude oil line. While a side-boom caterpillar supports the wrapper, the operator rides the machine itself, checking its work on the line. This operation was pictured on the spread near Kipling, Saskatchewan.



Potential Increasing Faster Than Markets

This promise of wider markets is a further incentive for the drilling of new wells. Producers are now held down by severe daily market quota restrictions imposed due to the lack of outlet. In May the daily acceptance per well was set at 60 and 45 bbl, respectively, for Leduc Woodbend's D3 and D2 zones, 60 bbl for Redwater, 160 bbl for Golden Spike, 60 for Excelsior, and 45 for Joseph Lake. All these per well quotas are less than the Conservation Board allowables, which are set for summer months at rates double the above for Leduc, 3 times greater for Excelsior, 4 times greater for Redwater, and 6 times greater for Golden Spike.

Even these vast present plans to reach wider markets may prove somewhat disappointing to individual producers. If the completion of new wells continues at merely the present rate over the next 4 or 5 years, quotas will have to be held down even as the outlet increases. Taking a careful look at possible increases in prairie con-

sumption over this period, and adding these to the planned stepup in pipe line outlets to the head of the Lakes for tanker delivery to Ontario points, it becomes apparent that present output of about 62,000 bbl daily may be roughly doubled by the end of 1952, and may attain a rate not exceeding 140,000 bbl daily by the end of 1953, depending on the amount of storage available at Superior, Sarnia, and Toronto. On top of this, assuming no change in world prices for petroleum, Alberta wellhead prices may suffer a drop of about 40 cents a barrel, or about 13 per cent, so that Alberta oil can compete with present prices at Sarnia.

The cumulative result of such developments does not point to any sharp increases in revenues per well. Worked out on an average basis, dividing the probable average number of producing wells each year into the probable average daily marketable production, it may be seen that returns per well are unlikely to increase by more than 10 to 20 per cent or thereabouts during the next three years. By 1953, the returns per well may exceed present returns by possibly 30 to 40 per cent.

Thus it may be necessary to look further ahead for possible markets other than central and western Ontario, which areas should be fully served by 1953 or 1954 by the pipe line now being built. Of the several potential markets; Montreal, Chicago, St. Paul-Minneapolis, Vancouver, and points in the Pacific northwestern states; an outlet at Vancouver for sufficient oil to make a pipe line pay might have the least effect in lowering wellhead prices in Alberta. The Vancouver market, however, is now only about 14,500,000 bbl a year, too small in itself to justify a 600-mile oil pipe line through the mountains, or to permit Alberta oil to compete with oil imported from California as at present.

If, however, Alberta oil could also find a market in the Portland and Seattle areas, which are also being supplied from California, then a pipe line across the Rockies might be justified. Such an outlet might also have the effect of lowering wellhead prices at Edmonton still further. This possibility is currently being fully investigated. The outlook is clouded, however, by possible opposition from competitive California producers. The question of quotas, embargoes, and perhaps higher tariffs arises as well. The U. S. tariff on imported oil was increased on July first to 21 cents per barrel.

Gas Export May Further Stimulate Exploration

Further developments are pending in Alberta that may widen the interest in exploration and pipe lines. During the last two sessions of the Canadian Parliament, four natural gas companies have obtained authority from the Canadian Government to incorporate. Their purpose is delivery of natural gas to Winnipeg, Vancouver and points in the Pacific northwestern states. They still have to obtain authority from the Province of Alberta to export the gas.

Westcoast Transmission Company, backed by Frank McMahon, Pacific Petroleums, Sunray Oil Corporation, and Eastman Dillon and Company, seeks to follow an all-Canadian route from Edmonton through the Yellowhead Pass, following the route of the Canadian National Railway to Kamloops, thence via Princeton and Hope to Vancouver and on to Seattle and Portland. Alberta Natural Gas, backed by A. F. Dixon and Morgan Stanley Company of New York, has made surveys for several routes. One is an all-Canadian route starting from Edmonton and passing through Calgary, then through the Crows Nest Pass. It crosses the other mountain ranges just north of the U.S. border, and supplies Canadian consumers first, including Vancouver. Their all-American route, after passing through Calgary and the Crows Nest Pass, crosses the U.S. Border at Kingsgate, north of Spokane, for serving Spokane, Seattle, and Portland first, and supplying what is left to Vancouver. The latter is claimed to be the lowest cost route for construction and operation, and serves the largest market.

Several companies seek permission to build gathering lines, or a grid system connecting all important Alberta gas fields, which will be necessary for tying in all gas fields whatever route is chosen for export. Another company, Western Pipe Lines, wants to supply Winnipeg.

Almost 2 years ago the Alberta Natural Gas Commission reported to the Alberta Government on the potential reserves of gas, at that time estimated at some 5 trillion cubic feet, and the possible domestic market for it. Since that time, no announcement as to policy on exports has been forthcoming from Premier Manning of Alberta, but current estimates of reserves have been raised, and now exceed seven trillion cubic feet. Some experts believe present reservs about 10 trillion cu ft. In the United States, about five trillion feet of gas has been discovered with every billion barrels of oil. Such a yardstick indicates what

Welders go to work to tie-in another joint of pipe as construction progresses on Interprovincial Pipe Line Company's crude oil line from the Alberta oil fields to Superior, Wisconsin, on the Great Lakes. A side-boom caterpillar holds the 40-foot joint of pipe in position after the line-up crew has put it in place for the welders, near Hardisty, Alberta.

might be expected in the Canadian prairie provinces. Hearings will be held during October that may result in a decision to permit exports.

Assuming export to the United States is allowed by Alberta, it next devolves upon the Canadian Board of Transport Commissioners to decide which company gets the right to build the pipe line and which route that company must follow. If the Board should declare in favor of a line through Idaho and Washington, they will have to justify it on the basis of common sense and hard economic facts, for during the recent sessions of Parliament, opposition members put up a strong fight for an all-Canadian route.

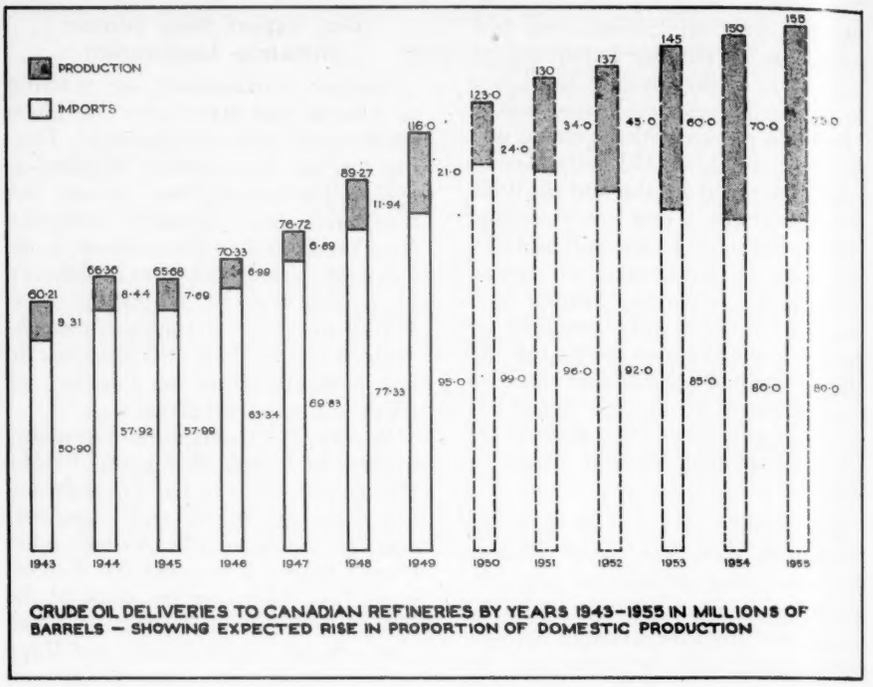
If gas export were permitted, particularly via the northern route, it could have the effect of diverting the interest to potential gas producing areas, to some extent retarding the discoveries in predominently oil-bearing fields, leaving the accessible oil markets to be shared by fewer oil wells, thus tending toward easing up on present quota restrictions.

But north Pacific state cities will probably not wait indefinitely for Alberta natural gas, with other sources available to them. Already Texas producers have applied for permission to build pipe lines to these areas, though Alberta gas fields have the advantage of being only half the distance away. But alternative mass markets are as close, or closer to Texas than to Alberta gas fields. Even the Ontario market for natural gas is turning to Texas sources, whence gas may be obtained via shorter pipe lines than would be needed for Alberta gas.

There are many variables to consider. About all that may be concluded is that no great increase in returns per oil well can be expected during the next 3 or 4 years. Most of the larger oil companies are financially able to go on drilling and proving up reserves with the assurance that they are building up an investment that should ultimately pay off. On the other hand, smaller companies may have to ease up on their exploration.

Benefits From Greater Oil Production

The people of Alberta particularly, and Canadians in general, are benefitting widely from these developments. The Province of Alberta is presently receiving an income from oil royalties at the rate of some $5,500,000 a year, and with completion of the pipe line, this revenue should more than double. Besides this, some $35,000,000 have been received to date from the sale of oil leases.



CRUDE OIL DELIVERIES TO CANADIAN REFINERIES BY YEARS 1943–1955 IN MILLIONS OF BARRELS — SHOWING EXPECTED RISE IN PROPORTION OF DOMESTIC PRODUCTION

The total of all direct revenue from oil accounts for almost a third of the entire provincial revenue. Indirect revenue through taxation of the many new enterprises and the circulation of money spent for exploration and development is also adding indirectly to both provincial and federal revenues. Expenditures in the oil industry this year is expected to approach 10 per cent of total Canadian private domestic investment.

A 40 cent reduction of well head prices at Edmonton on the completion of the pipe line might result in lower prices for petroleum products that would help western farmers and encourage new industries to take advantage of lower fuel costs and cheaper raw materials for petro-chemical industries. Oil and gas producing, refining, and exportation should provide the prairies with another major industry besides agriculture, and thus reduce the impact of drought, depression, or the reduction of export markets for food products.

The saving in the outlay of scarce United States dollars is another advantage accruing to Canada by mounting production of Canadian oil. Though increasing consumption maintained the needed outlay for U.S. petroleum at around $275,000,000 in 1949, without this domestic production it would have amounted to $365,000,000. Following upon the completion of the pipe line and the displacement of U.S. oil presently reaching Ontario points from the Illinois and other Mid-Continent fields, a third of Canada's needs may be met from domestic sources and some $140,000,000 annual outlay of U.S. dollars may be saved.

A market in the north Pacific states, added to a 50,000,000-bbl market yearly in the prairie provinces and Ontario, could bring Canada a further $125,000,000 American dollars yearly, on top of the saving in U.S. dollars through supplanting imports into Ontario from Mid-Continent fields. But refinery capacity in Oregon and Washington is presently lacking.

Benefits to North America

This saving of U.S. dollars to Canada does not mean curtailment of trade. It only diverts Canada's U.S. dollar resources to the purchase of greater quantities of the thousand and one products of U.S. industry that Canada needs.

From the point of view of continental defense, the discovery of these additional reserves is an additional source of security to both countries. Even in peacetime, the development and marketing of this oil can benefit both countries, if it is done in such a way, regardless of boundaries, that each source as far as possible supplies the nearest and most suitable area of consumption.

Whatever may be the sequence of these forthcoming developments over the next few years, one of the most important oil fields in the world is in the making in the Canadian Northwest. Nothing short of other huge discoveries in this hemisphere, or a sharp break in prices, due to the impact of Middle East oil, can stop it rolling.

* * *

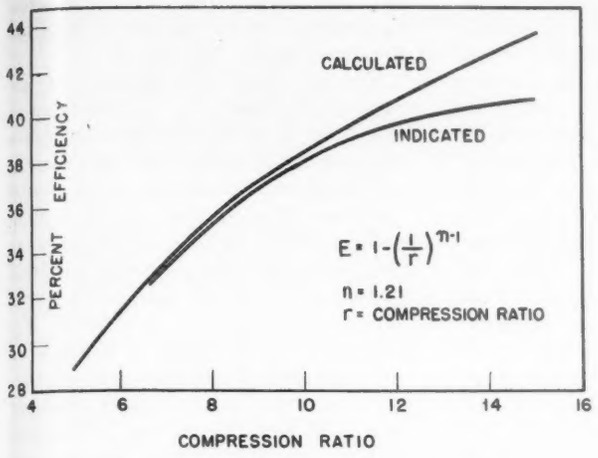


FIG. 1. Comparison of calculated and indicated thermal efficiencies.

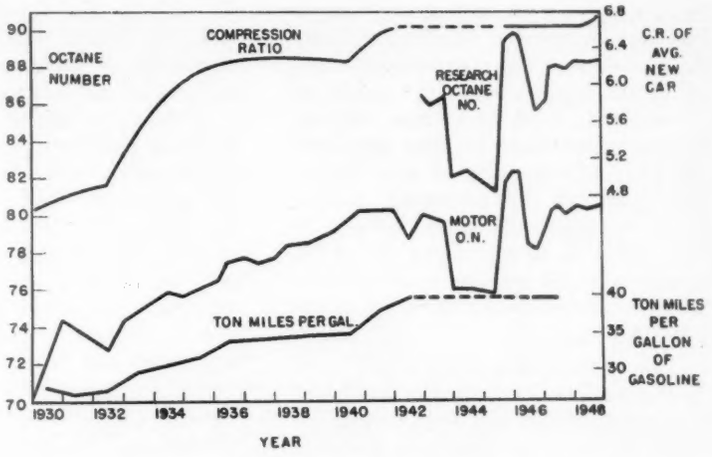


FIG. 2. Trend in U. S. premium grade motor gasoline, antiknock quality, engine compression ratio and gasoline economy.

The Influence of Engine Trends on Future Fuels*

J. F. KUNC, JR.†

RECENT trends in automotive, aviation, and diesel engine design, and their influence on the fuel quality requirements of these engines are reviewed in this paper. As the automotive engine field is the largest fuel consumer and is also the one currently showing the most activity as far as design changes are concerned, it will be discussed first.

Automotive Engines and Fuels

One of the most important recent developments in the automotive engine field was the announcement and demonstration by Mr. Kettering of the General Motors Corporation that the building of gasoline engines of up to 12:1 compression ratio was entirely feasible and practical. Prior to this demonstration, most automotive engineers had reached the conclusion that an upper limit of perhaps 8 to 1 compression ratio might eventually be reached in automotive engines over a relatively long period of time. Experimental attempts to exceed this figure had been universally unsuccessful, and some experimenters had actually demonstrated that by the time 8 to 1 compression ratio was reached, engine power and fuel economy had passed the optimum value and had actually started to decline. It now appears in retrospect that the unsuccessful attempts to build engines of really high compression ratio were due to lack of stiffness in the engine crankshaft with the result that when high pressures existed, the bending of the crankshaft increased bearing and piston friction to a point where the power and economy gains theoretically to be realized by raising compression ratio were negated in overcoming the higher engine friction. With a crankshaft of adequate design, the Kettering engine operated perfectly satisfactorily at 12:1 compression ratio and showed essentially the power and economy predicted for it on theoretical grounds. In the two years since the Kettering engine was announced, the General Motors Corporation has put two cars on the market, namely: The Cadillac and the Oldsmobile Rocket, which are equipped with engines structurally capable of being increased to 12:1 compression ratio without any major retooling as quickly as the petroleum industry can supply fuels of suitable antiknock quality for these engines. This development by GM is probably indicative of a general trend in the automotive industry to build engines of higher compression ratio, and over the next several years pressure will continually be brought to bear on the petroleum industry to increase the antiknock quality of the available gasolines, especially in the premium grade.

Some of the aspects of the engine compression ratio problem and its relation to the gasoline quality problem are illustrated in Figs. 1 to 4. Fig. 1, which illustrates the relation between engine thermal efficiency and compression ratio, shows the well-known fact that thermal efficiency increases as an exponential function of compression ratio. The calculated curve is based on the formula $E = 1 - \left(\frac{1}{R}\right)^{n-1}$, where E is effiicency and R is compression ratio. The calculated curve in Fig. 1 was developed by General Motors using a valve of 1.21 instead of the usual value of 1.4 for the ratio of specific heats in the air cycle formula. The justification for the use of the lower exponent is the fact that polytropic exponents of the working fluid, as observed during expansion in gasoline engines, are consistent with specific heat ratios of about 1.2. Moreover, the ratios of specific heats of the expanding gases in the cylinder, as determined from spectroscopic, specific heat data at actual working temperatures between 3500 and 4000 F, lie much closer to 1.2 than to 1.4.

The point of interest in Fig. 1 is that indicated efficiencies for actual engines approach the calculated curve rather closely, at least up to compression ratios of 10:1. The reasons for the differences between the calculated and observed values at compression ratios above 10:1 have not been well-established thus far. For orientation purposes it might be well to point out that

*Presented at a meeting of the Department of Standards and Tests and the Department of Manufacture of the National Petroleum Association at the Esso Research Center on June 2, 1949.

†Esso Laboratories, Standard Oil Development Company.

the average current automotive engine has a compression ratio of roughly 6.7:1, whereas the compression ratio of diesel engines is in the range of 13 to 16:1. It is, of course, obvious that as automotive engines approach the 12:1 level established as a reasonable goal by the Kettering engine, these engines will show efficiencies very close to those of the diesel engines, but will naturally operate on widely different types of fuel than the latter engines.

The changes that have taken place in the antiknock quality of premium grade gasoline since 1930 and the corresponding changes that have occurred in the compression ratio and fuel economy characteristics of passenger car engines are illustrated in Fig. 2. It will be noted that over the period in question the antiknock quality of the average premium grade gasoline, as indicated by the Motor Method, has risen from roughly 70 to 80. Corresponding Research octane number data are not available for the entire period in question, as this test method is relatively new compared to the Motor Method, but it is evident that they are showing the same trend as Motor Method octane numbers. In the interest of brevity, antiknock quality trends for regular grade gasolines are not shown in Fig. 2, but they have paralleled those for the premium grade gasolines at a lower level. As the result of the availability of gasolines of improved antiknock quality, the average compression ratio has risen from 4.8 to 6.8 in the past 18 years, and fuel economy expressed in terms of 10 miles traveled per gallon of gasoline has improved from 26 to 40 or 54 per cent. The entire increase in fuel economy cannot be explained on the basis of compression ratio increase alone. Actually, about one-half of the indicated improvement in economy is due to compression ratio increase and the remainder is attributable to improvements in engine design.

An estimate of what will be required in the way of gasoline antiknock quality as compression ratio is increased and the accompanying improvements in gasoline economy that might be anticipated are presented in Fig. 3. In going from the present level of 6/7 compression ratio to the region of 10-11:1, antiknock quality must be raised from roughly 85 Research octane number to the vicinity of 100. It should be borne in mind that the relationship shown is an estimate based on the available data and at best represents only the average situation. Wide variations exist in the antiknock requirements of present production engines of a given compression ratio due not only to the fundamental differences in design, but also to minor variations in constructional details and engine adjustments. In extreme cases these variations may amount to 20 octane numbers in requirement for engines of the same make and model. The extent to which engine builders can eliminate these variations in their future designs and also build "mechanical" octane numbers into these designs will control the ultimate nature of the relationship between compression ratio and antiknock quality requirement. It is anticipated that future engines of high compression ratio will tolerate fuels of high sensitivity (difference between Research and Motor octane number) as shown in Fig. 3. It also appears that Research octane number will continue to be controlling as far as the low speed antiknock requirements of engines are concerned and will therefore be the limiting consideration, since the low speed requirements of engines are more critical than high speed requirements.

As indicated in Fig. 3, fuel economy in terms of miles per gallon should improve some 35 per cent as compression ratio is raised from 6.7:1 to the region of 10:1.

The economic significance of improving fuel economy is illustrated in Fig. 4. It is evident from this figure than an improvement of 1 per cent in fuel economy calculated on an annual gasoline consumption of 31 billion gallons would mean a saving of some $60,000,000 when assuming gasoline to cost 20 cents per gallon or would permit travelling an additional 5½ billion car miles with no increase in consumption. If existing cars were replaced at the rate of 3,000,000 per year with new cars giving 10 per cent more miles per gallon, the average annual saving over a 10-year period would amount to 300 million dollars or 10 billion car miles assuming an operating cost of 3 cents per car mile.

Considerable interest has been evinced during the past year or so in the use of auxiliary fuel injection devices such as the Thompson Vita-Meter, as well as the dual fuel system proposed by Holaday of the Socony-Vacuum Oil Company. Both of these

FIG. 3. Relationship between engine compression ratio, octane requirement, and gasoline economy.

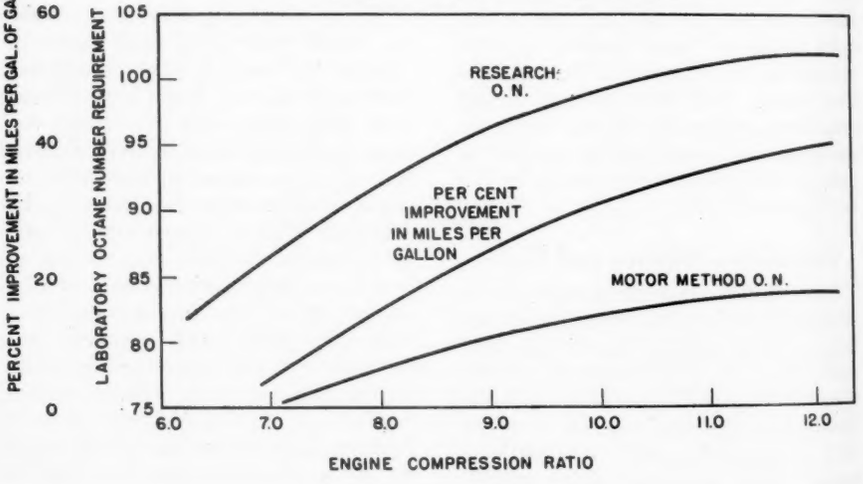


FIG. 4. ECONOMIC IMPORTANCE OF FUEL CONSUMPTION.

Annual consumption of gasoline (1946).....31 billion gallons
Value of 1% saving in dollars per year at 20c/gal.....60 million dollars
Increase in car miles per year at 18 mpg.....5½ billion car miles

Replacing 30 million cars at the rate of 3 million per year
with cars having 10% more miles per gallon
would reduce the fuel bill
1% each year for 10 years
until all cars would give 10% more mpg
During the 10 years
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which is equivalent to
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10 billion more car miles at 3c/car mile

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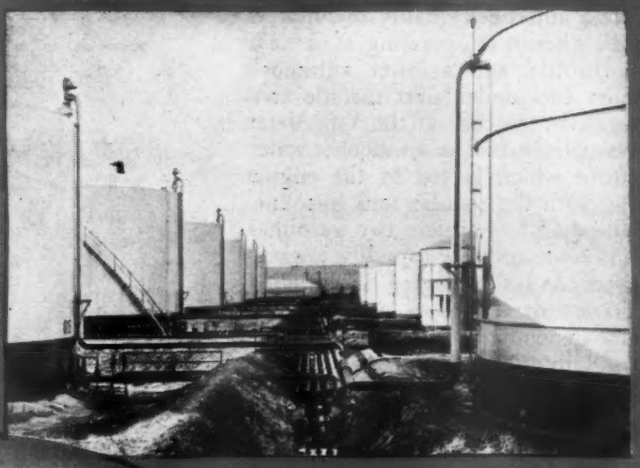

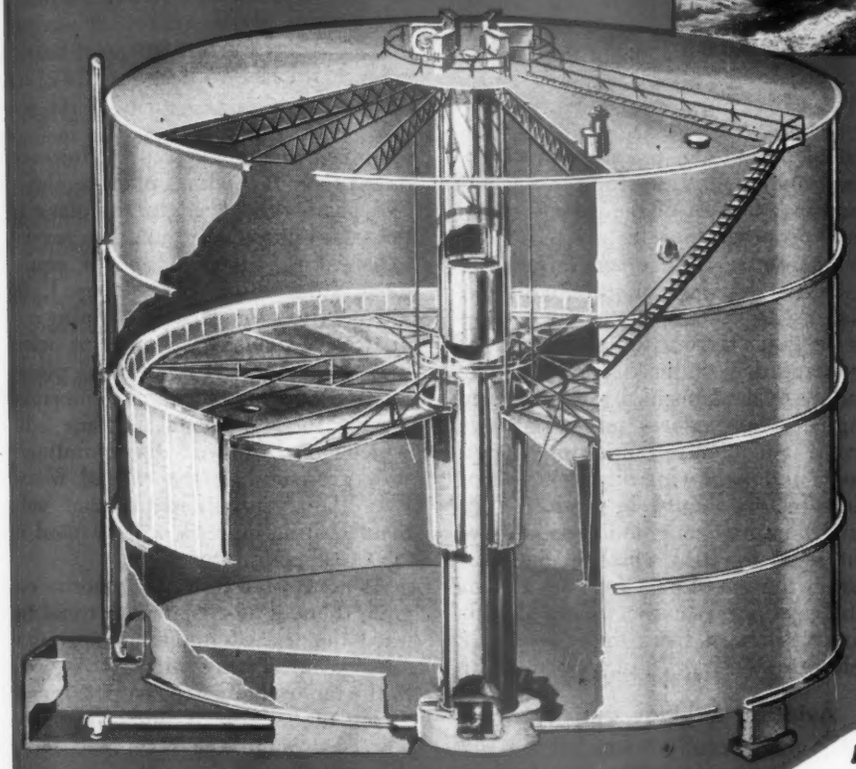

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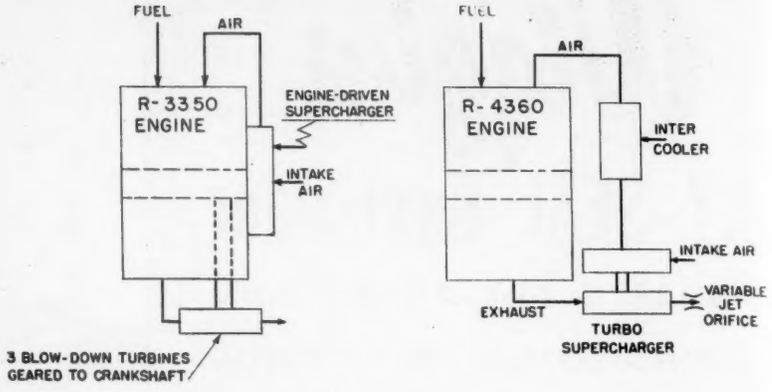
devices supply the engine with fuel of high antiknock quality to suppress knock when it is operating at or near full throttle, and a lower antiknock quality fuel under part throttle conditions. In the case of the Vita-Meter the auxiliary fuel is an alcohol-water mixture which is fed to the engine along with the regular tank gasoline. In the dual fuel system two gasolines of different antiknock quality are employed, and the engine is supplied with one or the other of these two fuels, depending on manifold pressure. Both of these schemes have considerable technical merit for the intended purpose, but neither appears to be economically justifiable, at least in the United States.

There is a definite trend on the part of passenger automobile builders to replace the conventional gear type transmission with automatic or semi-automatic transmissions such as the hydramatic drive, dynaflow drive, etc. It is estimated that slightly over 2,000,000 cars have been built with automatic or semi-automatic transmissions since they were first introduced in 1938. Currently, 25 per cent of the cars being produced in the United States have transmissions of this type. It is difficult to predict what the overall influence of automatic transmissions may be on the antiknock requirements of engines. It appears possible, however, that the use of torque converter type transmissions such as the Buick dynaflow type may tend to place more emphasis on the high speed antiknock quality characteristics of gasolines, since the torque converter does not load the engine at low speeds. Accordingly, the Motor Method octane number of gasolines may assume considerable importance if torque converter type transmissions are used extensively.

There do not appear to be any trends in engine design that will materially influence the volatility of cleanliness characteristics of motor gasolines in the immediate future. The use of automatic chokes is rapidly expanding, but their use will not affect gasoline volatility requirements, since automatically choked cars appreciate fuels of high middle and back end volatility to the same extent, from the standpoint of warm-up performance, as manually choked cars. The vapor locking characteristics of some automobiles have been slightly improved through the use of better fuel pumps and more advantageous location of fuel lines. However, these changes will not permit the use of gasolines having significantly poorer vapor lock protection characteristics than those now marketed. The use of fuel injection rather than carburetion probably would permit the use of appreciably less volatile gasolines than those now required, but all of the injection systems proposed thus far are too costly to warrant serious consideration.

FIG. 5. New compound engines.



Engine builders are gradually beginning to recognize the advantages to be gained from the standpoint of reducing fuel induced engine sludge and varnish deposits by maintaining engine temperatures at reasonable levels, adequately ventilating crankcases, and employing oil filters. All of these factors should, in the long run, tend to improve engine life somewhat, but it is doubtful whether they will permit the use of gasolines having engine cleanliness characteristics significantly different from those currently being produced.

Aviation Engines and Fuels

Up until recently it was felt that the days of reciprocating engines for use in both military and commercial aircraft were numbered because of the rapid strides being made in the development of jet engines. However, reciprocating engines compounded with turbines to take advantage of the energy available in the exhaust gases from the reciprocating engine are now receiving a considerable amount of attention because of the excellent fuel economy characteristics possible with combinations of this type compared to present jet engines.

At the present time it appears that jet engines will be used extensively in military fighter aircraft and may be used to some extent in bombers. Compounded reciprocating engines are being seriously considered, especially for use in long range bombers, because of fuel economy and range considerations. In the commercial field, reciprocating engines undoubtedly will be used extensively for some years to come because of the large investments which airlines have in relatively new equipment of this type. However, Trans-Canada Airlines plans to obtain one prototype jet engine airplane in the near future to accumulate service experience with this type of equipment. In addition, one or two U. S. airlines are considering obtaining one or two jet airplanes in order to determine the practicability of using planes of this type in regular commercial service. In the personal airplane field, which has shown disappointingly slow growth since the end of World War II, it is anticipated that only reciprocating engines will be used in the foreseeable future.

As contrasted to the automotive engine, there is no particular trend toward the use of higher compression ratio reciprocating aircraft engines. In the latter engines the emphasis continues to be toward obtaining more power through (a) supercharging either mechanically or by means of exhaust gas turbines, or (b) coupling exhaust gas turbines directly to the main engine crankshaft. Diagrams illustrating the type of compound engines being built by the Wright Aeronautical Corporation and by Pratt and Whitney are shown in Fig. 5. In the case of the Pratt and Whitney VDT engine, exhaust gases from the normal R-4360 reciprocating engine are fed to a turbine which drives a supercharger for the intake air. The turbo-supercharger is equipped with a variable jet orifice for controlling the operation of the exhaust gas turbine. In the Wright Turbo-Cyclone engine three blow down turbines operated by the exhaust from a standard R-3350 engine are geared directly to the main crankshaft of the engine to increase power output. In this case a supercharger driven by the engine is used to supply engine combustion air. In both engines the overall thermal efficiency of the power plant is improved by virtue of the fact that

energy from the exhaust gases that is normally wasted is converted to useful work.

The trend toward increased supercharging or reciprocating aircraft engines with accompanying increased power output has raised the fuel antiknock quality requirements of these engines. The petroleum industry has been instrumental in permitting the development of the truly outstanding aircraft reciprocating engines available today by supplying fuels of higher and higher antiknock quality. Fig. 6 shows the annual United States demand for aviation gasolines of various antiknock quality levels during the period from 1932 through 1948. Prior to 1937 the best fuel available was roughly 91 octane number. The development of the alkylation process during the middle 1930's made the production of Grade 100/130 aviation gasoline possible, and the tremendous volumes of this quality gasoline made by the petroleum industry during World War II are a matter of common knowledge. At the close of World War II Grade 115/145 aviation fuel was made available, and fuel of this quality is being used to good advantage in the latest design large aircraft engines.

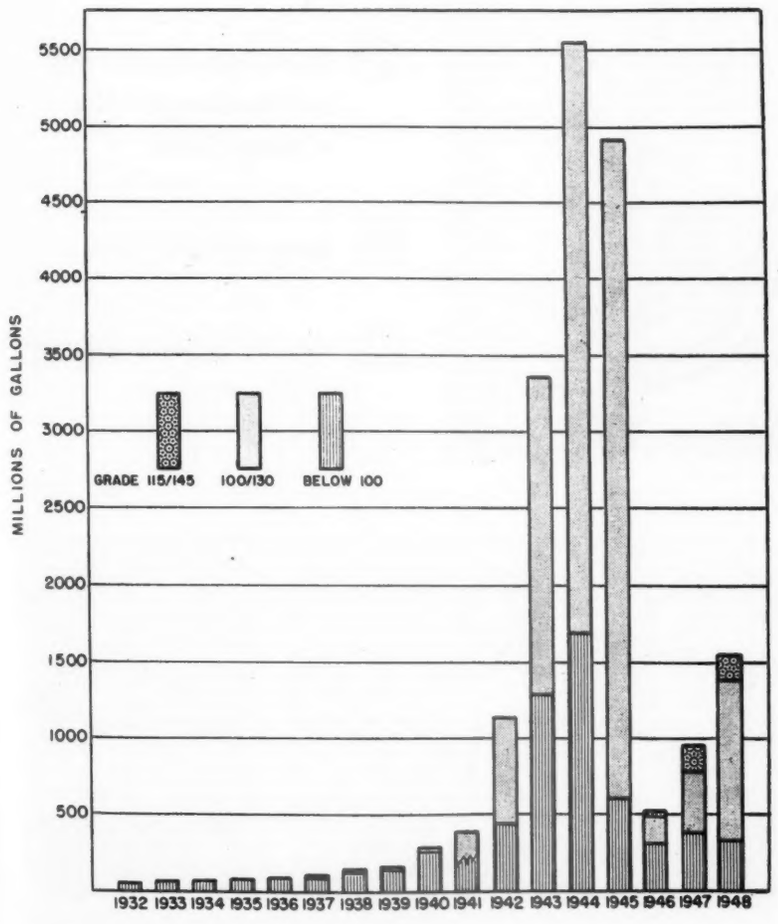
TABLE 1. Turbo-jet engine fuel specifications.

Spec.	Gravity API	Flash point F	RVP PSI	ASTM Distillation F 10%	ASTM Distillation F 90%	ASTM Distillation F FBP	Aromatics %	Sulfur %
AN—F—32	35	110	....	410	490	572	20	0.2
(JP—1)	Min	Min		Max	Max	Max	Max	Max
AN—F—58A	45—63	...	5—7	....	400	600	25	0.5
(JP—3)	...	...		...	Min	Max	Max	Max

It is evident from Fig. 6 that if the artificial demand for aviation gasolines created by the war during the period from 1942 to 1945 is neglected, the demand for aviation gasolines has increased steadily since 1932, and it is expected to continue to increase at a steady pace, at least for the next several years.

It is difficult to predict at this time whether fuels higher in antiknock quality than Grade 115/145 will be required for use in the newer compounded engines or in future design engines. If higher quality fuels are needed, however, they probably can be supplied, although this may mean some sacrifice in the total available quantity of aviation gasoline. There are not trends evident in the design of reciprocating aircraft engines which will materially influence the volatility or other characteristics of aviation fuels aside from antiknock quality.

FIG. 6. U. S. aviation gasoline demand.
(Exclusive of export)



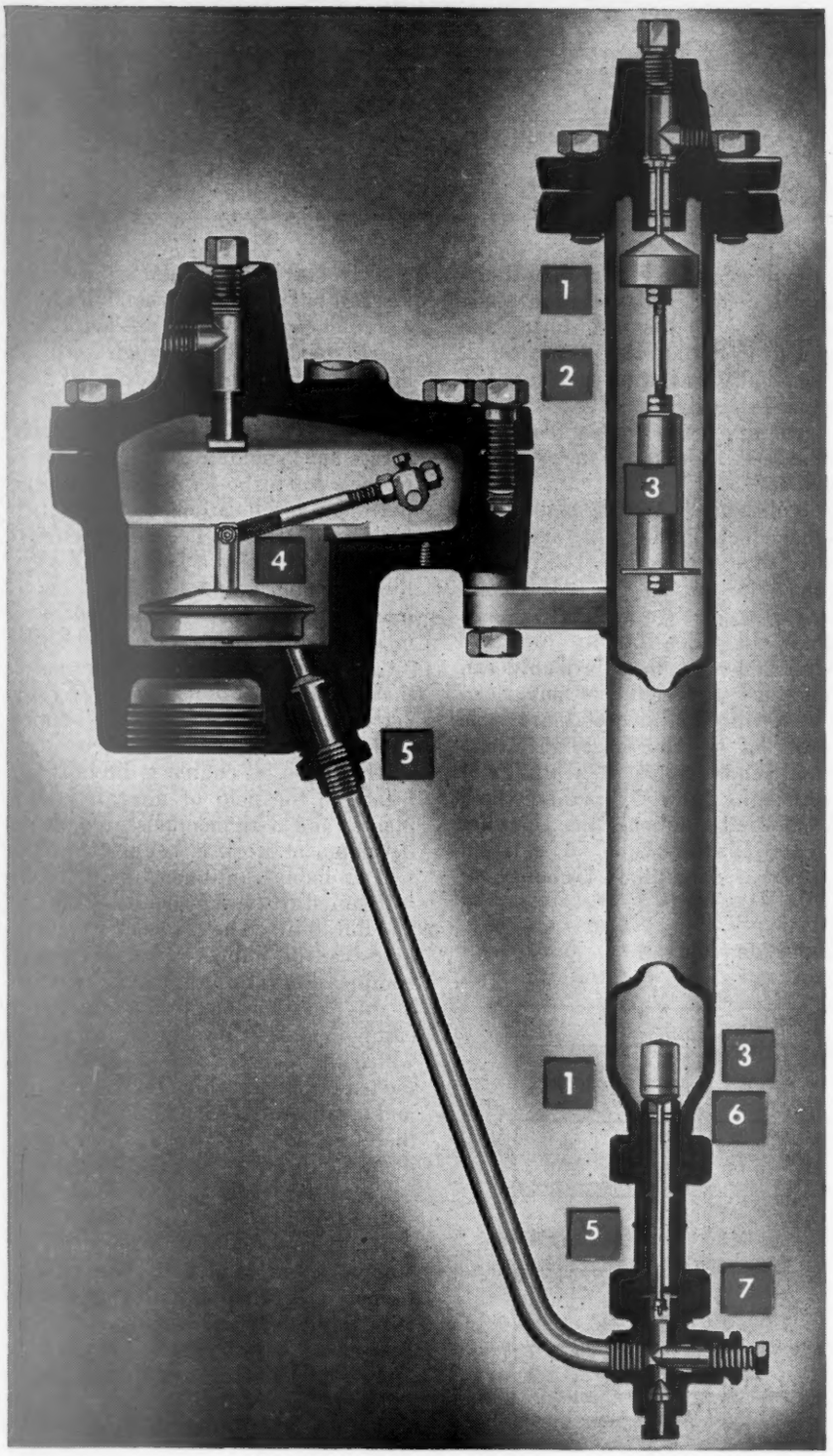
The currently available turbo-jet aircraft engines will successfully burn a rather wide variety of petroleum fuels from gasoline through kerosine and light heating oils, provided that their sulfur and aromatic content is not unduly high. The U. S. military forces have standardized on two types of fuels for turbo-jet engines, and the pertinent specifications for these two fuels are shown in Table 1. Fuel AN-F-32 is essentially a kerosine of very low freezing point (— 76 F maximum). Fuel AN-F-58a is a product of much wider boiling range than AN-F-32 and is designed from the viewpoint that it could be supplied readily by the petroleum industry in large volumes in the event of an emergency.

The turbo-jet engine is literally an infant in the field of aircraft power plants, and a tremendous amount of development work is being done and will probably continue to be done on it in an effort to improve its efficiency and durability. The efficiency of jet engines can be improved by increasing compression ratio in the same manner as this can be accomplished in reciprocating engines. However, the extent to which this can be done is limited by the temperatures which turbine wheels and combustors will stand. It appears, therefore, that the principal improvement in turbo-jet engine design will come as the result of the development of improved materials of construction.

It appears doubtful if the turbo-jet engine proper will ever become extremely critical of fuel quality. However, limitations imposed by accessory equipment, as well as by flight temperatures, rates of climb, operational altitudes, range considerations, etc., may make one type of fuel more desirable than another. For instance, it may develop that one particular type of fuel is eminently suitable for military use, whereas another may prove to be more suitable for commercial airline operation. Regardless of the direction that turbo-jet engine developments take in the future, it should not prove very difficult for the petroleum industry to supply fuels of adequate quality for engines of this general type with existing processes and equipment.

Diesel Engines and Fuels

There have been no really new or startling developments in the diesel engine field during the past several



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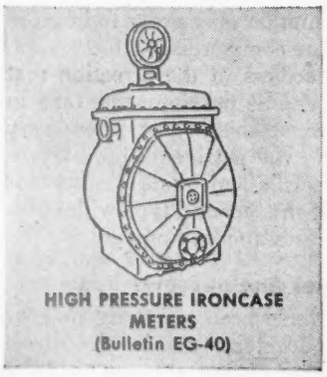
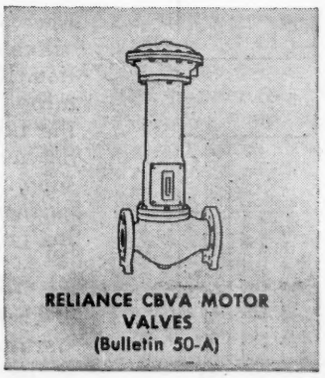
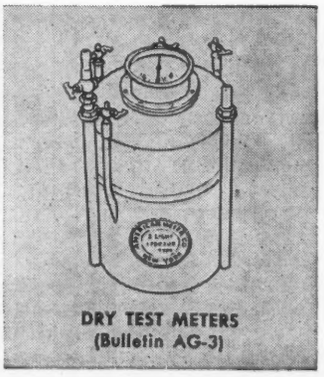


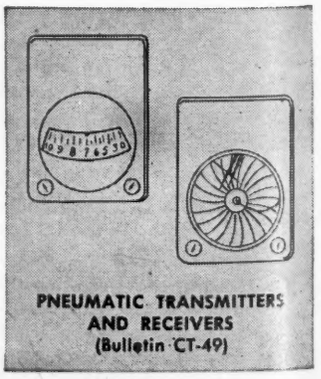
HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)



RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)



DRY TEST METERS
(Bulletin AG-3)



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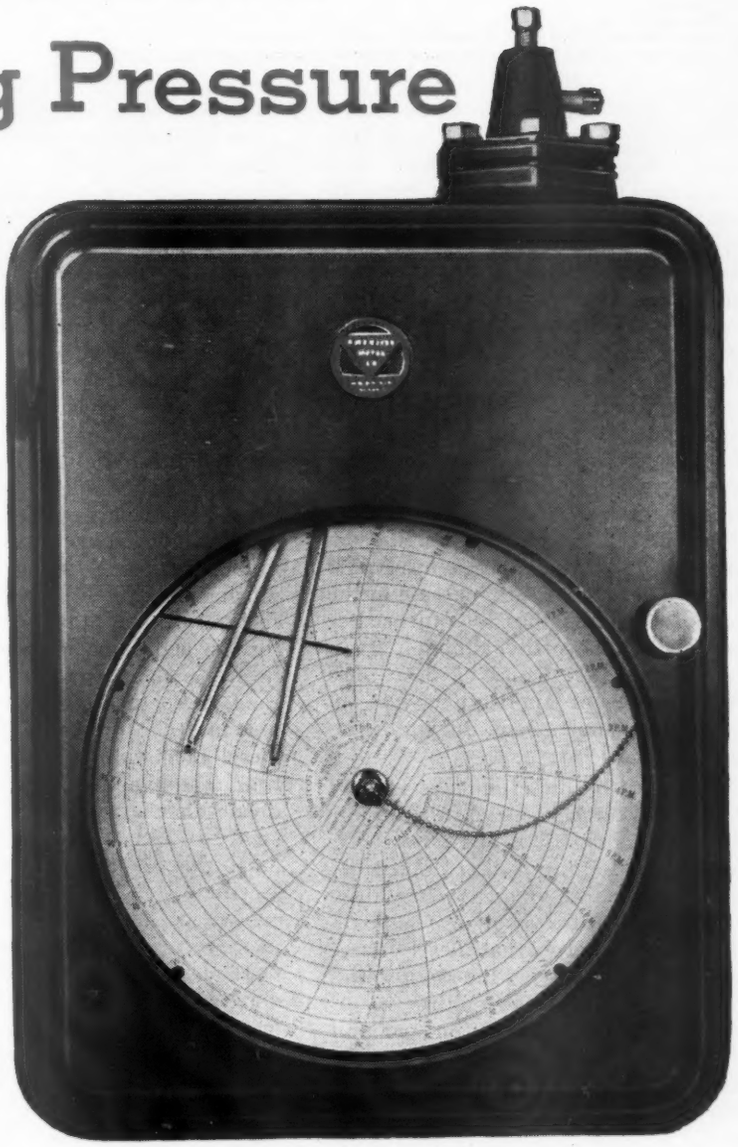

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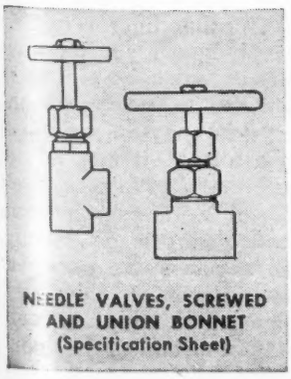
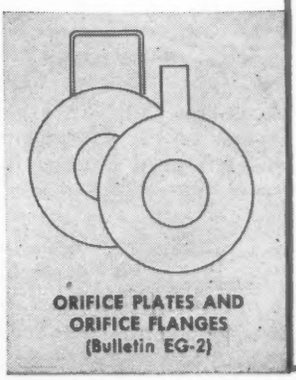


NEEDLE VALVES, SCREWED AND UNION BONNET
(Specification Sheet)



ORIFICE PLATES AND ORIFICE FLANGES
(Bulletin EG-2)

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TABLE 2. Diesel fuel demand (United States).

Use	1941 B/D*	1941 %#	1948 B/D*	1948 %#	1952 B/D*	1952 %#
Railroads	7.5	10	82.	34	158.0	45
Vehicles	14.9	20	37.9	15	62.8	18
Ships	29.0	39	38.4	16	41.1	12
Manufacture and utility	13.8	18	50.2	20	54.3	16
Miscellaneous	9.8	13	36.6	15	32.8	9
Total	75.0	100	245.3	100	349.0	100

*Thousands
#Per cent of total
Source: Standard Oil Co. (N.J.)—Coordination and Economics Dept.

years, although improvements in the reliability of diesel engines have been made steadily. Diesel engines have continued to grow rapidly in popularity, especially for certain applications where the inherently good thermal efficiency of diesel engines makes their use particularly attractive. Furthermore, it is anticipated that their usage will increase. The U. S. demand for diesel fuel by field of use during the period from 1941 to 1948 and the anticipated demand in 1952 is shown in Table 2. The total demand for diesel fuel increased from 75,000 bbl per day in 1941 to over 245,000 bbl per day in 1948, and it is expected that the demand in 1952 will be for some 349,000 bbl per day. The rapid increase in the use of diesel engines by railroads is especially noteworthy, although it will be observed that the use of diesel fuels in all types of applications has increased, to some extent, during the interval since 1941.

Most of the diesel engines now in use have compression ratios in the neighborhood of 13 to 16:1 and, therefore, there is little to be gained from an efficiency standpoint by increasing compression ratio. There are some indications, however, that diesel engine builders are exploring the possibilities of supercharging their engines in order to increase power output per unit of displacement and, therefore, per unit of weight. An example of what can be done in this connection is illustrated in Table 3, which compares the power output and weight of a conventional and a supercharged 12 cylinder engine presently being made by a U. S. diesel engine builder. The supercharged version gives 25 per cent more power with a negligible increase in total engine weight. Based on available single cylinder engine test data, the supercharging of diesel engines probably will increase deposit formation and wear considerably when the engines are operated on the usual diesel fuels and ordinary heavy duty lubricating oils. As shown in Table 4, increasing the power output of a single cylinder diesel engine from 75 to 135 BMEP by supercharging increased deposits by 50 per cent and doubled engine wear. Perfectly acceptable performance can be obtained in the single cylinder supercharged engine, however, by employing special heavily detergent compounded oils which have recently become available, as the last column in Table IV demonstrates.

It appears quite probable that the emphasis in diesel fuels in the future will be on the quantity available at reasonable cost from petroleum rather than on improvement in quality. The ignition quality (cetane number) of present diesel fuels appears adequate for existing engines, as well as for engines of future design. Fuels of better ignition quality will be needed only if highly supercharged diesel engines of relatively low compression ratio are built, and there does not appear to be much incentive to proceed in this direction. It may prove advantageous for the petroleum industry in the future to make somewhat wider boiling range diesel fuels than those now available in order to increase the supply of diesel fuels without increasing crude runs. The available technical data indicate that a considerable improvement in yield can be obtained by following this course without materially sacrificing fuel quality. The sulfur content of diesel fuels will probably increase in the future because of the fact that newly discovered crude sources appear, in general, to be higher in sulfur content than their predecessors. The use of higher sulfur content diesel fuels will result in increased engine deposits and engine wear, but the present indications are that both of these factors probably can be satisfactorily controlled by the use of the proper lubricating oils. The sulfur content of diesel fuels can be reduced by refining, but the cost of this refining must be passed along to the consumer, and in the long run, will result in a much higher cost to him than that incurred through the use of appropriate lubricating oils.

TABLE 3. Conventional vs supercharged diesel engine (12 cylinder—1200 rpm).

	Conventional	Supercharged
Wt., pounds	10,800	11,000
Horsepower	400	500
BMEP, PSI	105	131

TABLE 4. Influence of diesel engine supercharging on fuel and lubricant performance (single cylinder engine tests).

Engine	Conventional	Supercharged	Supercharged
BMEP	75	135	135
Fuel	A	A	A
Lubricant	A	A	B
Relative wear	100	200	<100
Relative deposits	100	150	<100

Summary

In summary, there appears to be definite desire on the part of automotive engine builders to increase the compression ratio of passenger car engines to take advantage of the significant improvements in fuel economy obtainable by pursuing this route. The petroleum industry will be required to furnish motor gasolines of improved antiknock quality if improved engines are to be made available. It is unlikely that the petroleum industry will be called on to supply motor gasoline of radically different volatility or cleanliness characteristics in the foreseeable future.

In the field of aviation fuels a demand for higher antiknock quality fuels for use in reciprocating engines compounded with turbines may develop, but a firm statement on this point cannot be made at the present time. It appears that reciprocating engines will continue to be used in both military and commercial aircraft for some years to come. It is not anticipated that aviation fuels of materially different volatility or stability characteristics from those currently available will be demanded in the future.

A wide variety of fuels ranging from gasoline through kerosine and even light heating oils can be burned successfully in aviation turbo-jet engines, provided that their sulfur and aromatic content is not unduly high. Although jet engines are undergoing relatively rapid developmental changes, it does not appear that they will ever pose any unusual problems to the petroleum refiner from a fuel quality standpoint. It is conceivable, however, that different types of jet fuel may be desired for military and commercial use.

In the diesel fuel field it appears that the principal emphasis in the future will be on the quantity of fuel available, rather than improvement in quality. There is currently no incentive to make fuels of higher ignition quality available. In order to make the large indicated future requirements of diesel fuels available, it may be advantageous for refiners to make fuels with a broader boiling range than those currently being made. Finally, future diesel fuels may be somewhat higher in sulfur content which may lead to engine deposit and wear problems unless appropriate engine lubricating oils are used. * * *

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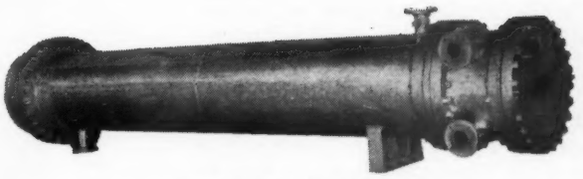

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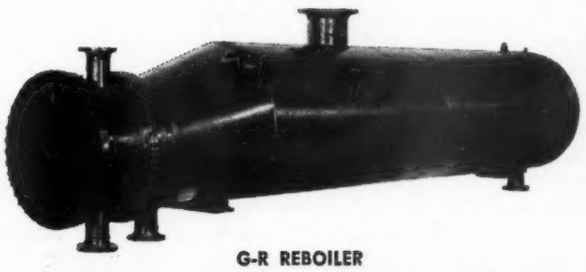

G-R REBOILER
Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.

G-R TYPE B HEATER
A simple, practical design, highly efficient on moderate pressure, moderate temperature duties.

GRISCOM-RUSSELL

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PETROLEUM PROFILE

ANY old-timer, or new-timer for that matter, in the oil fraternity will tell you that John Leslie Latimer is "Slats" Latimer, president of Magnolia; that he is an affable, informal person who has spent nearly 35 years in the petroleum industry and knows it from the loading rack where he began as a helper, to the 24th floor of Dallas' Magnolia Building where his office is now. They'll say, too, that he's the same there as he is on a rig floor or pipe line station talking to a group of men who form a part of the 12,500 persons who get things done every day for the company.

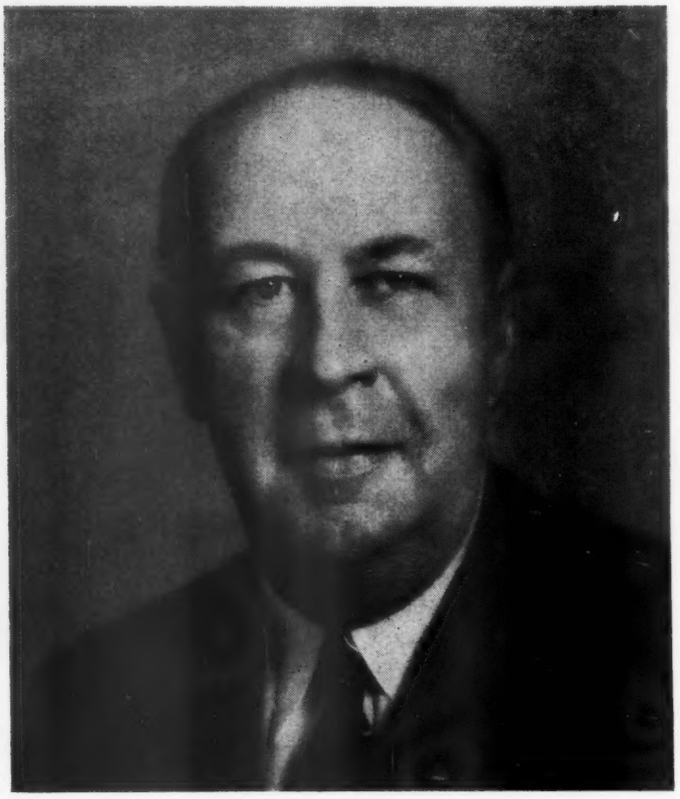
J. L. Latimer was born in Olean, New York, May 11, 1897. As that little city was at that time one of the few oil centers of the infant petroleum industry, he received his first introduction to crude oil and its products there as a kid. It was only a speaking acquaintance, though, as he knew little about the business when he came to Thrall, Texas, at the age of 18 to begin working one cold December evening in 1915 on the night shift at a small Magnolia loading rack for 25 cents an hour. It was there that the then thin young man first was called "Slats" by his co-workers. That name has stuck ever since.

From the loading rack, J. L. Latimer was transferred to a pipe line gang and then moved up as oiler, engineer, and then gauger in Texas and Oklahoma. He was getting around a lot over Magnolia's pipe line operations but took time out to serve in the Navy during World War I. After that hitch, which lasted more than a year, he returned to Magnolia in 1919 as a gauger in the Ranger field, which at that time was at the peak of its activity. Advancements to chief gauger, district foreman, and oil solicitor followed and then he was given the tough job of constructing the company's first welded trunk line between Luling and Hull station, a junction point on Magnolia's main line extending from Beaumont to North Texas and Oklahoma. Welded main lines were something new for a young pipeliner in 1924 but the successful completion of the job won for him a promotion to district pipe line superintendent of Magnolia's Southwest Texas District with headquarters in Luling.

In August, 1934, Latimer was made Magnolia Pipe Line Company's general superintendent of Texas, Louisiana, and Arkansas with headquarters at Dallas. On March 1, 1937, he was advanced to assistant general manager of that company and in April, 1938, was elected vice president, director, and manager of Magnolia Pipe Line Company. At the same time he was also elected vice president and a director of Magnolia Petroleum Company. On January 1, 1946, thirty years and fifteen days after he first started working for Magnolia, J. L. Latimer was made president of both companies.

During Word War II, Latimer was a member of the P. A. W. District 3 Supply and Transportation Committee, and associate member of the Sub-Committee on Pipe Lines in connection with postwar disposal of pipe lines, refineries and tankers.

Latimer is a director and vice president of the Dallas Citizens Council, a director of the Dallas Grand Opera Association, Trinity Improvement Association, Texas Utilities Company, and the Republic National Bank. He is a past director and vice president of the Dallas Chamber of Commerce and is now a member of four of its important committees, a trustee of the Texas Research Foundation, and a member of the General Transportation Committee of the A.P.I. and of the Greater Dallas Planning Council, as well as several other industry and civic organizations both national and local.



J. L. LATIMER, President
Magnolia Petroleum Company
Magnolia Pipe Line Company

Although Magnolia was founded April 24, 1911, its roots extend deep in the industrial history of the Southwest as its real beginning was when the refinery stills of one of its predecessor organizations was first lighted on Christmas Day, 1898.

The job of being chief executive of such a pioneer company in the highly competitive oil business today demands much of a man. His three-fold responsibility to the employees of the organization, to the stockholders, and to the public that the company serves must be fulfilled while maintaining established traditions and policies that have to be kept flexible in the day-to-day job of directing the operations of the company. These qualifications call for a big man. They are being met by aggressive, genial J. L. Latimer.

Technological Improvements Increase Reserves

ALTHOUGH new petroleum reserves are more difficult and expensive to discover as the search for oil and gas expands into new areas or into deeper formations, countless improvements in the technology of exploration, drilling, and production are increasing our reserves from both new fields and old fields. It is true, of course, that present higher prices for petroleum extend the commercially productive life of marginal wells, but all the costs of drilling and production have also increased. The increase in producing capacity and reserves, therefore, would not be nearly so large as it is were it not for the countless technological improvements that have been made and continue to be made in exploration, drilling, and production practices.

Some of these improvements are readily apparent to those who have witnessed the changes in equipment design and operating practices since the discovery of Spindletop, Ranger, or even East Texas. The drilling rigs and derricks are more portable, more powerful, and more flexible than ever before. They can drill faster, deeper, and straighter with much less effort on the part of the driller and crew and with more safety from accidents or blowouts.

These modern rigs have been improved in nearly every detail from the drilling bits at the bottom of the hole to the crown blocks on the derricks. Exploration and production equipment has likewise been improved, so that oil and gas can be found and produced more efficiently.

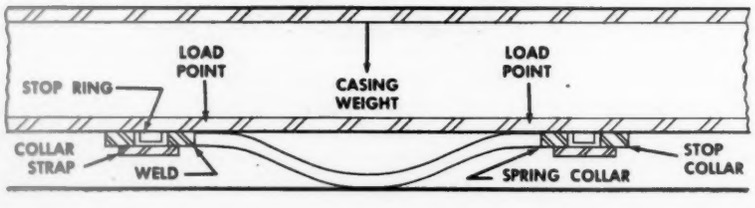
Other technological improvements are not so apparent even to those who have witnessed the changes in the equipment. Drilling mud, for example, still looks about the same as ever to the casual observer. It is not the same, however, for today's drillers must know a lot about the technology of drilling mud and how to make and keep it ready to drill through high pressure sands, salt water flows, or heaving shale. They must also know how to mix the mud to keep from losing circulation and having a blowout, and how to keep the mud from damaging a formation.

The net result of the countless technological improvements in oilfield practices is that more oil and gas can be found and produced with today's tools, equipment, and know-how than ever before in the history of the industry. Commercial production can now be established from deep, thin, low capacity oil and gas pools that would have been abandoned in earlier periods as "non-commercial." Technological improvements in production practices may be credited also with the rejuvenation of commercial production in hundreds of pools that were on the brink of abandonment, partially abandoned, or, in many cases, totally abandoned. The technology of petroleum production is an unfinished story of progress.

K Marshall Fagin

Use the only centralizer that

The Baker Model "G" Casing Centralizer is the only spring-type centering device that EFFECTIVELY CENTERS your casing at all critical cementing points.



THIS SIMPLE ILLUSTRATION REVEALS THE IDEAL IN SPRING DESIGN AND MOUNTING, WHICH IS FOUND ONLY IN THE BAKER MODEL "G" CASING CENTRALIZER. Note how the load point is imposed directly upon the casing; and how the properly "contoured" spring is free to move along the smooth surface of the casing as the spring deflects under compression. There is no chance for concentration of stress to cause a permanent set, or to result in breaking the spring. Note that ample clearance exists between Stop Rings and Spring Collars to accommodate the increased length of the springs which results from their complete flattening as the centralizer passes dog-legs or tight spots in the hole.

Adjusting Casing After Cementing for Stress Control at the Freeze Point

Discussion of the Effect of "Slacking Off" Some of The Casing Load at Wellhead After Cementing a Well

B. E. CURRAN*

WHEN, prior to cementing, a string of casing is freely suspended in a hole filled with drilling fluid, the weight of the entire string, less buoyancy, *must* be sustained as a hanging load by the cross-sectional area of the pipe at the surface. After cementing, however, the case is different. At least a portion of the string below the top of the cement is "frozen in" or immobilized so that it can no longer be considered an active influence so far as the actual hanging load is concerned. This, of course, does not mean that the prevailing stress at any point is changed by the mere fact of the fixation of the frozen length. If the prevailing stress at the freeze point, with due consideration for the effect of buoyancy, happened to be a tensile stress before cementing, it will, if otherwise undisturbed, remain as such after cementing. The significant difference, however, is this.

After cementing, if it is considered undesirable, it is no longer *necessary* for the free length to continue supporting the load originally imposed on the system by the buoyant weight of the frozen length. By simply "slacking off" or adjusting the strain in the free length, the residual stress at the freeze point can be varied to any extent, or relieved entirely. Relieving the strain in the free length merely transfers the freeze point load to the cement sheath through which it is transmitted as a shear stress to the wall of the hole and the surrounding formations.

Most operators are well aware of these facts and fully appreciate their significance. When it comes to putting them into practice, however, there seems to be a considerable difference of opinion as to just how much slackoff to allow for. Many operators have a feeling that the least they can do is to slack off enough to account for the buoyant weight of the frozen length. Others, however, feel that this is an exaggerated over-simplification of the problem involved, and that the determining factor in the final analysis is the amount of thermal expansion and/or contraction of the free length that may have to be accommodated. Their theory is that, once a string of casing is run in the hole, it quickly attains an equilibrium with the ambient subsurface temperature gradient, and that, after the heat generated by the setting cement has been dissipated, this equilibrium is re-established without any particular effect on the preexisting stress conditions. Thereafter, however, any heating or cooling effect due to fluids being produced or circulated will contribute to the expansion or contraction of the free length, and this, in turn, can materially alter the stress pattern. They feel, therefore, that enough residual stress to compensate for any thermal expansion, plus an additional amount to provide for a reasonable margin of safety, should be retained at the freeze point in the free length at all times. This they consider essential to prevent the free length from slacking off thermally and being subjected to the hazard of buckling by column action under compressive stress. By pursuing this line of reasoning still further, however, it can easily be seen that, depending on the position of the freeze point and temperature rise to be accommodated, the actual adjustment required might be in the nature of a pickup instead of a slackoff. To some this does not sound unreasonable, but to others it seems to be a completely anomalous circumstance that they want to shy away from instinctively. The purpose of this article, therefore, is to attempt to reconcile these various viewpoints by reviewing and rationalizing the background for the casing slackoff problem in general.

To begin with, the casing slackoff problem is essentially a matter of stress analysis in a long slender column. Because the casing is immersed in a column of fluid, however, any attempt to rationalize the problem also involves the concept of buoyancy.

As far as a relatively compact object is concerned, this concept is readily explained. If we consider a short cylindrical solid suspended so that it is fully immersed in fluid in an upright position, we find that it is buoyed up by a force equal to the weight of the fluid it displaces. This occurs because of the difference between the hydrostatic pressures that are effective at the top and at the bottom of the cylinder. Thus the force that acts downward on the top of the cylinder is the product of the hydrostatic pressure at the depth of the upper surface times the cross-sectional area exposed to it. The force acting upward against the bottom of the cylinder is the product of the prevailing pressure at the depth of the lower end times the cross-sectional area of the bottom. The resultant force acting on the object is simply the difference between these two forces. And as the excess acts in an upward direction against the bottom of the cylinder, it gives rise to a buoyant effect that partially offsets the weight of the cylinder.

If we compute the difference between the hydrostatic pressures acting on the top and bottom, respectively, we find that it is equal to the hydrostatic pressure that would be exerted by a column of fluid having a height equal to the upright length of the cylinder itself. Reduced to these terms, the excess hydrostatic force acting on the cylinder as a buoyant effect is equivalent to the product of the density of the fluid, the length of the cylinder, and its cross-sectional area. But as this is equivalent to a quantity of fluid having the same volume as the cylinder itself, it is easy to see why the proposition, when reduced to the simplest terms, is expressed by merely stating that the buoyant force acting on a body is equal to the weight of the fluid displaced by the body.

The significant feature to remember,

*Chief Engineer, Kerotest Manufacturing Company, Pittsburgh, Pennsylvania.

EXCLUSIVE

however, is the fact that buoyancy acts on the bottom of a body. If the fluid has no access to the bottom, there can be no buoyancy. This proposition can be very effectively demonstrated by means of an apparatus so simple that it can be understood not only correctly but intuitively without having to resort to any particular mathematical proof.

This apparatus consists of a polished metal bar suspended from a spring scale so that it extends through a hole bored in the bottom of a thick-bottomed metal container. The clearance between the bar and the hole should be a relatively close, sliding fit so that a given height of fluid can be maintained surrounding the bar without excessive leakage, but loose enough so that friction will not interfere with weight measurements. When the bar is surrounded with fluid it weighs just as much as when the container was empty, naturally. There is no buoyancy because the fluid has no access to the cross-sectional area. If this is so with respect to the system we have been considering, it is also true of a string of casing suspended in fluid as shown in Fig. 1.

By giving due consideration to the foregoing principles, it can be shown, as was done in Equation (14) of Appendix 1 at the end of this article, that the total amount of stretch "s_a" over the entire length of a string of casing "l" due to axial considerations only would be given by,

$$s_a = \frac{l^2}{2E}\left(\delta - 2\omega\right). \quad (14)$$

where "E" is the modulus of elasticity, "δ" is the density of steel, and "ω" is the density of the fluid.

If we want to be more rigorous and take into account the lengthening effect due to the squeezing of the wall thickness by the application of lateral pressure as shown in Fig. 2, in addition to the axial effects of tension and buoyancy, a still better stretch formula can be obtained. Thus according to Equation (31) of Appendix 1 the cumulative amount of stretch "s_1" from the top of the string to any point "x" along its length due to the combined effects of tension, buoyancy, and lateral pressure would be given by,

$$s_1 = \frac{lx}{E}\left[\delta - \omega\right] - \frac{x^2}{2E}\left[\delta - 2\mu\omega\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

where "μ" is Poisson's ratio and the other terms have the same meanings previously assigned to them.

The cumulative elongation "s_2" along the remainder of the length from "x" to "l" would then be given by Equation (33) of Appendix 1 as,

$$s_2 = \frac{l^2}{2E}\left[\delta - 2\omega(1-\mu)\right] - \frac{lx}{E}\left[\delta - \omega\right] + \frac{x^2}{2E}\left[\delta - 2\mu\omega\right] \quad . \quad (33)$$

and the sum of Equations (31) and (33) would give Equation (34),

$$s = \frac{l^2}{2E}\left[\delta - 2\omega(1-\mu)\right]. \quad (34)$$

in which "s" now represents the total stretch over the entire length from top to bottom with due consideration for the combined effects of tension, buoyancy, and lateral pressure.

Equation (34) is the same as Equation (14) except for the expression $(1-\mu)$, which gives effect to Poisson's ratio. This difference being of no particular consequence, however, so far as stress analysis is concerned, as is pointed out in the discussion in Appendix 2, whatever is true of Equation (14), stress-wise, is also approximately true of Equation (34).

What then are some of the implications of Equations (14) and (34)?

For the sake of simplicity let us examine Equation (14). Suppose, for instance, that we assume the density "ω" of the fluid to be negligible in comparison to the density "δ" of the steel. Then $\omega = 0$ and Equation (14) becomes,

$$s_a = \frac{\delta l^2}{2E} \quad . \quad . \quad . \quad (14.1)$$

which is the well recognized formula for the stretch of casing suspended in air. This seems like a logical consequence and lends credence to Equation (14).

Suppose, then, that we assume $\delta = \omega$ so that Equation (14) now becomes,

$$s_a = \frac{l^2}{2E}\left(\omega - 2\omega\right) \quad . \quad (14.2)$$

$$= -\frac{\omega l^2}{2E} \quad . \quad . \quad (14.3)$$

A little reflection on the meaning of Equation (14.3) shows that it means that the stress $(-\omega l)$ due to the force of buoyancy would be exactly equal and opposite to the tensile stress (δl) due to the weight. Thus the stress would vary from $(-\omega l)$ at the bottom to zero at the top giving an average stress of $\left(\frac{-\omega l}{2}\right)$. This divided by "E" would give the amount of shortening per unit length "e",

$$e = \frac{-\omega l}{2}\Big/E \quad . \quad . \quad (14.4)$$

and this in turn multiplied by the total length "l" would give the total amount of shortening,

$$s_a = -\frac{\omega l}{2}\Big/E \cdot l \quad . \quad (14.5)$$

$$= \frac{-\omega l^2}{2E} \quad . \quad . \quad (14.3)$$

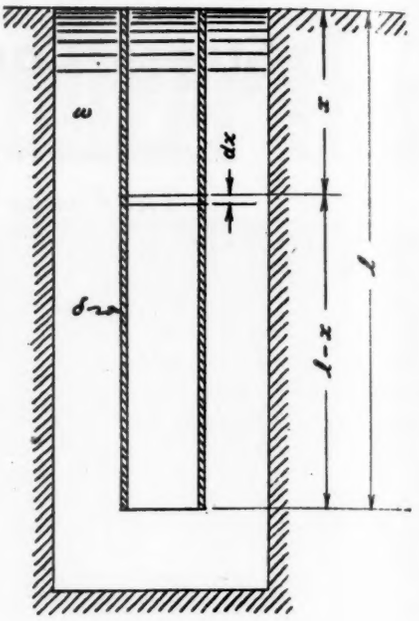


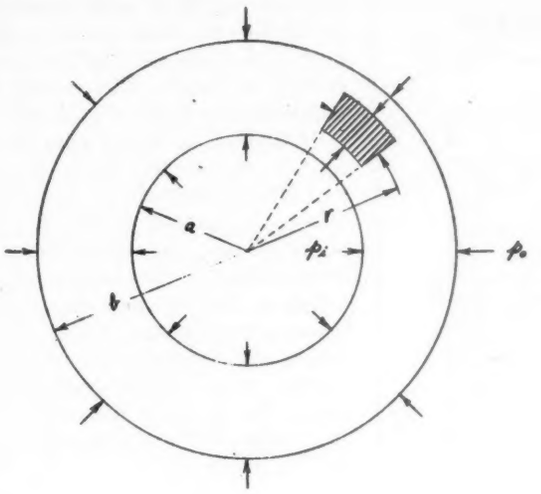
FIG. 1

This is the same effect as if we took a string of casing, of length "l" when laid out in a stress-free horizontal state, and then stood it on end in such a way as to prevent it from buckling. Its lower end would then be called upon to support the entire weight of its upright length in compression.

Thus we have seen that for casing suspended in air the point of zero stress is at the bottom, while for casing suspended in fluid having the same density as the casing material the point of zero stress is at the top. Therefore, if the density of the fluid lies between the densities given for air and steel, or if

$$0 < \omega < \delta \quad . \quad (14.6)$$

which is normal for most fluids, then there would be a point of zero stress that would lie at some intermediate position between the top and bottom of the string. The position of this point called the neutral point can be determined directly by the use of Equation (36) taken from the derivation given in Appendix 2,



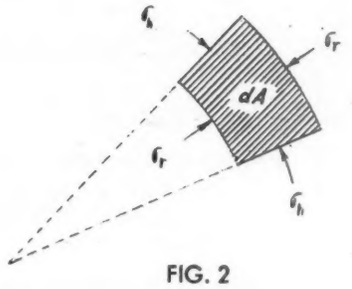


FIG. 2

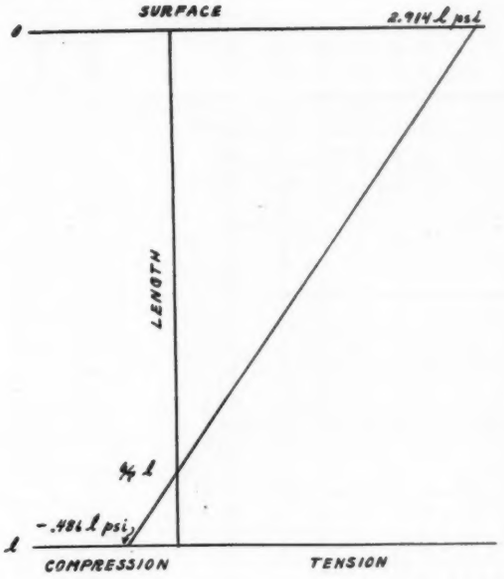


FIG. 3

$$\bar{x} = l\left(1 - \frac{\omega}{\delta}\right) \quad . \quad . \quad (36)$$

where "$\bar{x}$" is the distance of the neutral point from the top and the other terms have the same meanings as before.

Now that we have established the existence of a neutral point, we may proceed to represent the axial stresses in a string of casing, suspended in fluid, as shown in Fig. 3. Stresses to the right of the vertical axis are indicative of tension and those to the left represent compression.

Suppose now we wish to consider a string of casing suspended in a fluid having a density equal to 1/7 of the density of steel. By making $\omega = \delta/7$ in Equation (36) we obtain

$\bar{x} = \frac{6}{7} l$ . . . . . (36.1)

which shows that the neutral point "$\bar{x}$" would be situated $\frac{6}{7}$ of the length "l" from the top. Now if $l = 10{,}000'$ then,

$\bar{x} = \frac{6}{7} \times 10{,}000$ . . . . (36.2)

$= 8570'$ . . . . . (36.3)

And if the string were cemented back to the neutral point exactly, after cementing the casing would have a free length of 8570 ft and a frozen length of 1430 ft. Moreover, the stress at the top of the cement, or the freeze point as it is commonly called, would be exactly zero.

Suppose, however, that it was foreseeable that the production of warm fluid through the tubing might later raise the average temperature of the free length about 25 F, and that it was desired to provide enough tension at the freeze point to accommodate the corresponding expansion with a 20 per cent margin of safety.

Well, steel has a temperature coefficient of .0000069, which simply means that 1 in. of length will expand or contract .0000069 in. for each degree Fahrenheit of temperature change. Thus if we have a string of casing fixed at both ends, as the free length is after cementing, and heated it through one degree, each inch of its length would expand. 0000069 in.

It is well known, however, that the ratio of unit stress to unit strain is expressed by the modulus of elasticity "E"; or, conversely, that the unit stress is given by the product of the modulus multiplied by the unit strain. Thus, the unit stress "σ_e" corresponding to a unit strain of .0000069 in./°F. would be given by,

$\sigma_e = .0000069 \times 30{,}000{,}000$ (36.4)

$\sigma_e = 207$ psi/°F. . . . . (36.5)

To accommodate the thermal expansion due to a temperature rise of 25 F with a 20 per cent margin of safety, or with a safety factor of 1.2, would require a pre-existing tensile stress at the freeze point computed as follows:

$\sigma_t = (1.2)(25)(207)$ . . (36.6)

$= 6210$ psi . . . . . (36.7)

Earlier investigators have already suggested that a tensile stress of 6250 psi at the freeze point, arrived at in a similar fashion after studying the temperature conditions in a 12,000 ft well cemented back to 4000 ft, ought to be adequate for most cases.

The unit deformation "e" in inches per inch corresponding to a unit stress of 6250 psi would be given by,

$$e = \frac{\sigma_t}{E} \quad . \quad . \quad . \quad (36.8)$$

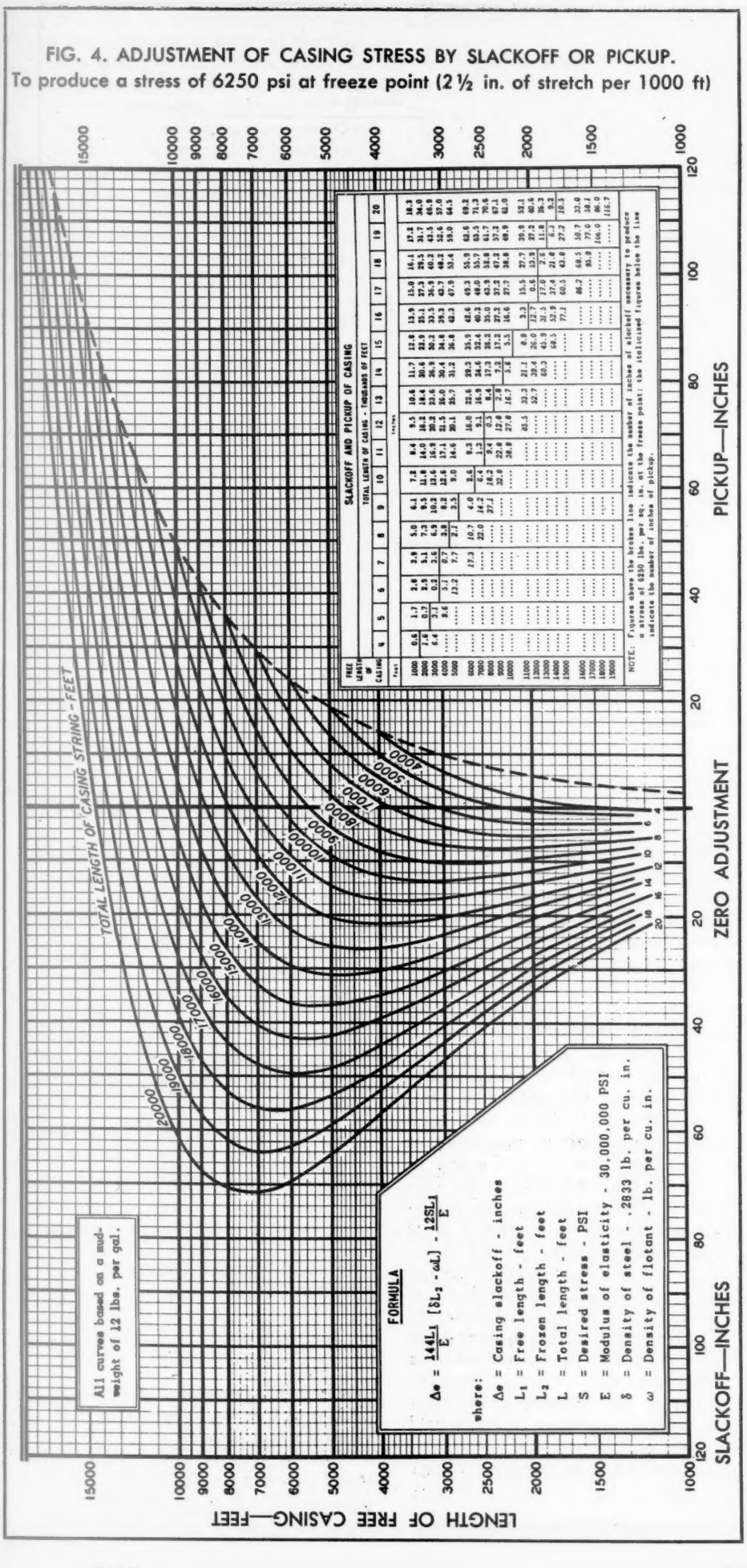
$$\text{or} \quad s_{1000} = \frac{(12)(1000)(6250)}{E} \quad . \quad . \quad . \quad (36.9)$$

$$= 2\tfrac{1}{2}''/1000' \quad . \quad (36.10)$$

where "s_{1000}" equals the stretch per 1000 ft of free length necessary to develop a stress increment of 6250 psi.

Now to return to our 10,000 ft string cemented back to the neutral point at 8570 ft. If we wanted to develop 6250 psi at the freeze point

FIG. 4. ADJUSTMENT OF CASING STRESS BY SLACKOFF OR PICKUP.
To produce a stress of 6250 psi at freeze point (2½ in. of stretch per 1000 ft)


SLACKOFF AND PICKUP OF CASING
TOTAL LENGTH OF CASING - THOUSANDS OF FEET
FREE LENGTH OF CASING
NOTE: Figures above the broken line indicate the number of inches of slackoff necessary to produce a stress of 6250 lbs. per sq. in. at the freeze point; the italicized figures below the line indicate the number of inches of pickup.
TOTAL LENGTH OF CASING STRING - FEET
All curves based on a mud-weight of 12 lbs. per gal.
FORMULA
$\Delta e = \frac{144L_1}{E}[\delta L_2 - \omega L] - \frac{12SL_1}{E}$
where:
Δe = Casing slackoff - inches
L1 = Free length - feet
L2 = Frozen length - feet
L = Total length - feet
S = Desired stress - PSI
E = Modulus of elasticity - 30,000,000 PSI
δ = Density of steel - .2833 lb. per cu. in.
ω = Density of flotant - lb. per cu. in.
PICKUP—INCHES
ZERO ADJUSTMENT
SLACKOFF—INCHES
LENGTH OF FREE CASING—FEET

in order to take care of a temperature rise of 25 F with a safety factor of 1.2, we could do so by picking up 2½ in. for each 1000 ft of the 8570 ft of free length. This would be 2.5 multiplied by 8.57 or 21.4 in.

If instead of being cemented just back to the neutral point, the casing had been cemented to a point 1430 ft above the neutral point, the tensile stress already prevailing there would be the same as the compressive stress acting on the bottom of the string due to buoyancy as their points of application are equally removed from the neutral point but in opposite directions. But as from Equation (5) of Appendix 1 the compressive stress "σ_c" is given by,

$$\sigma_c = -\omega l \quad . \quad . \quad (5)$$

$$= -\frac{.2833}{7}(12)(10{,}000) \quad . \quad (5.1)$$

$$= -4860 \text{ psi} \quad . \quad . \quad . \quad . \quad (5.2)$$

then the tensile stress "σ_t" would be,

$$\sigma_t = 4860 \text{ psi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5.3)$$

Thus there would be a tensile stress deficiency of the difference between 4860 and 6250 or 1390 psi. But if 2½ in. per 1000 ft is equivalent to 6250 psi then,

$$\frac{s}{1390} = \frac{2.5}{6250} \quad . \quad (5.4)$$

and

$$s = .556 \text{ in./1000 ft} \quad . \quad (5.5)$$

The pickup, then, necessary to produce a stress of 6250 psi at a point 1430 ft, above the neutral point or 2860 ft off bottom, would be .556 in. times each 1000 ft of the 7140 ft of free length, or only about 4 in.

Numerous other examples might be cited following the same general line of reasoning. Of course where the cement does not come up to the neutral point, the prevailing stress at the freeze point will be a compressive stress which must be added to the desired stress to determine the deficiency. Otherwise the procedure is much the same.

All of these calculations, however, can be considerably facilitated by the use of a mathematical expression which gives the amount of adjustment directly for any set of conditions and for any pre-determined amount of residual stress at the freeze point.

Suppose we take Equation (31) of Appendix 1, which represents the cumulative elongation from the top of a freely suspended string to any point "x" along its length, and use it to de-

termine the amount of stretch "e_1", which exists in the free length "a" of a string of casing having a total length "l". Substituting "a" for "x" and "e_1" for "s_1" we get,

$$e_1 = \frac{al}{E}[\delta - \omega] - \frac{a^2}{2E}[\delta - 2\mu\omega] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (31.1)$$

Similarly, if we use Equation (45) of Appendix 3 to determine the amount of stretch "e_2", which should exist in the free length "a" if it is desired to have zero stress at the freeze point after its lower end has been fixed by cementing, we obtain,

$$e_2 = \frac{a^2}{2E}[\delta + 2\mu\omega] \quad . \quad (45.1)$$

Now if we subtract Equation (45.1) from Equation (31.1) and use "b" to represent the frozen length we get,

$$\Delta e = \frac{a}{E}[\delta b - \omega l) \quad . \quad (45.2)$$

in which "Δe" represents the total amount of adjustment (slackoff if positive and pickup if negative) required to give zero stress at the freeze point.

The disappearance of Poisson's ratio "μ" from Equation (45.2) indicates the slackoff relationship to be entirely independent of any effect of lateral pressure and explains why this factor did not need to be considered in the numerical examples discussed earlier in the article.

Where a pre-determined amount of stress "S" at the freeze point is desired it can be provided for by simply subtracting

$$e_3 = \frac{Sa}{E} \quad . \quad . \quad . \quad (45.3)$$

from Equation (45.2) to give,

$$\Delta e = \frac{a}{E}[\delta b - \omega l] - \frac{Sa}{E} \quad (45.4)$$

In order to obtain "Δe" in inches where "a," "b," and "l" are in feet, Equation (45.4) should be modified to give,

$$\Delta e = \frac{144a}{E}[\delta b - \omega] - \frac{12\ Sa}{E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (45.5)$$

The chart shown in Fig. 4 is a graphic method for obtaining solutions to Equation (45.5) using a mud-weight of 12 lb per gal, or a density "ω" of .052 lb per cu in., and a required stress "S" of 6250 psi at the freeze point. The notation used on the chart is slightly different from that used in Equation (45.5) and is shown as,

$$\Delta e = \frac{144\ L_1}{E}[\delta L_2 - \omega L] - \frac{12\ SL_1}{E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (45.6)$$

where

Δe = Casing slackoff or pickup—inches
L_1 = Free length—feet
L_2 = Frozen length—feet
L = Total length—feet
S = Desired stress—psi
E = Modulus of elasticity — 30,000,000 psi
δ = Density of steel—.2833 lb per cu in.
ω = Density of flotant—lb per cu in.

Acknowledgment

Practically all of the equations in Appendix 1, with the exception of Equations (29) through (33), inclusive, and those in Appendix 2, with the exception of Equations (37) and (38), were taken from the unpublished works of J. L. Holmquist to whom the author gratefully acknowledges his indebtedness for permission to publish as background material necessary for arriving at a solution to the slackoff problem.

APPENDIX 1
Derivation of Equation for Stretch of Casing Freely Suspended in Fluid

a. Due to axial considerations only. Consider a string of casing of total length "l," freely suspended in a fluid of density "ω" as shown in Fig. 1.

If "dx" is an element of length located a distance "x" from the top of the string, then (l-x) is the length of casing suspended below this point. Furthermore, if "w" is the weight per unit length, then the hanging load "W" due to this suspended length would be given by w(l-x).

Now if "A" is the metal cross-sectional area of the casing, then the tensile stress "σ_t" is,

$$\sigma_t = \frac{w\ (lx)}{A} \quad . \quad . \quad . \quad (1)$$

But "$\frac{w}{A}$" is the density of the metal that can be designated by the constant "δ" Thus Equation (1) becomes,

$$\sigma_t = \delta\ (l\text{-}x) \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The hydrostatic pressure "p" developed at the lower end of the length "l" would be

$$p = \omega l \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This pressure would be exerted on the cross-sectional area at the lower end of the casing as a compressive stress "σ_c" that can be expressed as,

$$\sigma_c = -p \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$
$$= -\omega l \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where the negative sign (—) according to convention is indicative of compression.

Being an axial stress "σ_c" is transmitted over the entire length "l" and if unopposed would exert itself as an undiminished compressive stress at the surface. It is opposed by the oppositely directed tensile stress due to the weight of the casing, which is cumulative upward in proportion to the distance above the bottom of the string.

Thus the net stress "σ_a" due to axial considerations only (i.e. neglecting for the moment the influence of lateral pressure) can be obtained by taking the algebraic sum of Equations (2) and (5),

$$\sigma_a = \sigma_t + \sigma_c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$
$$= \delta\ (l\text{-}x) - \omega l \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$
$$= l\ (\delta - \omega) - \delta x \quad . \quad . \quad . \quad . \quad (8)$$

Then the net elongation or stretch "ds" of the element of length "dx" of Fig. 1 due to the combined effects of tension and buoyancy would be given by,

$$ds = \frac{\sigma_a}{E}dx \quad . \quad . \quad . \quad . \quad (9)$$

$$= \frac{l\ (\delta - \omega) - \delta x}{E}dx \quad . \quad (10)$$

where "E" is the modulus of elasticity.

The cumulative elongation or stretch "s_a" from the top of the string to any point "x," due to axial considerations only, would then be given by the integral of Equation (10) from zero (at the surface) to "x" as follows:

$$s_a = \int_0^x \frac{l(\delta - \omega) - \delta x}{E}dx. \quad (11)$$

$$= \frac{lx}{E}(\delta - \omega) - \frac{\delta x^2}{2E} \quad . \quad (12)$$

If we plotted Equation (12) for successive values of "x" from x = o to x = l we would find that "s_a" takes on a series of values going through a maximum at

$$\bar{x} = l\left(1 - \frac{\omega}{\delta}\right) \quad . \quad . \quad . \quad (13)$$

and returning to a lower value at x = l. This latter value for "S_a" can be determined by substituting "x" for "l" in Equation (12) giving,

$$s_a = \frac{l^2}{2E}(\delta - 2\omega) \quad . \quad . \quad (14)$$

in which "s_a" is the total net stretch over the entire length "l" of a string suspended in fluid of density "ω," but with respect to axial considerations only, i.e., neglecting the effect of lateral pressure.

b. Due to Lateral pressure only. If we want to take account of the effect of lateral pressure, some further consideration is necessary. For instance, if a moderately thick-walled cylindrical section, such as casing of inside diameter "a" and outside diameter "b," is submitted to the action of uniformly distributed internal and external pressures, "p_i" and "p_o" respectively, the distribution of stresses can be represented as shown in Fig. 2.

Now if "σ_h" denotes the tangential hoop stress and "σ_r" the normal radial stress acting on the sides of an element of cross-sectional area "dA," then these stresses may be expressed as,

$$\sigma_h = \frac{a^2p_i - b^2p_o}{b^2 - a^2} - \frac{(p_i - p_o)\,a^2b^2}{r^2(b^2 - a^2)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

$$\sigma_r = \frac{a^2p_i - b^2p_o}{b^2 - a^2} + \frac{(p_i - p_o)\,a^2b^2}{r^2(b^2 - a^2)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

(see Timoshenko, Strength of Materials, Vol. 2, pp. 237-239).

The total stress "σ_p" due to lateral pressure then is the sum of Equations (15) and (16) or,

$$\sigma_p = \frac{2(a^2p_i - b^2p_o)}{b^2 - a^2} \quad . \quad . \quad (17)$$

which remains constant over the section. This simply means that deformation of all elements in an axial direction is the same; or, in other words, that plane cross sections of the cylinder remain plane after deformation by lateral pressure.

If the internal and external pressure are the same, then,

$$p = p_i = p_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

and

$$\sigma_p = -2p \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where the negative sign (—) again denotes compressive stress.

Therefore, if the fluid in which the casing string of Fig. 1 is immersed has a density of "ω," then the pressure "p" acting laterally on the cross-sectional area of the element of length "dx" at a depth "x" would be,

$$p = \omega x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

and the stress "σ_p" as defined by Equation (19) due to this pressure becomes,

$$\sigma_p = -2\omega x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

and the corresponding elongation "ds" of the element of length "dx" due to this stress would be,

$$ds = -\mu\frac{\sigma_p}{E}dx \quad . \quad . \quad (22)$$

$$= -\mu\frac{(-2\omega x)}{E}dx \quad . \quad . \quad (23)$$

$$= \frac{2\mu\omega x}{E}dx \quad . \quad . \quad (24)$$

where "μ" is Poisson's ratio and the initial negative sign (—) indicates that the resultant axial deformation is opposite in sense to the lateral deformation that gave rise to it.

The cumulative elongation or stretch "s_p" from the top of the string to any point "x" along its length "l," due to lateral pressure only, is then given by the integral of Equation (24) between the limits of zero and "x." Thus

$$s_p = \int_0^x \frac{2\mu\omega x}{E}dx \quad . \quad . \quad (25)$$

$$= \frac{\mu\omega x^2}{E} \quad . \quad . \quad . \quad (26)$$

If "x" equals "l" then,

$$s_p = \frac{\mu\omega l^2}{E} \quad . \quad . \quad . \quad (27)$$

and "s_p" is the expression for the total elongation or stretch of the entire string due to the influence of lateral pressure only.

c. Due to combined effect of axial stress and lateral pressure. The net elongation "ds" of the element of length of Fig. 1 due to the combined effect of tension, buoyancy, and lateral pressure can then be expressed by the sum of Equations (10) and (24) in the following manner.

$$ds = \frac{(\delta - \omega) - \delta x}{E}dx + \frac{2\mu\omega x}{E}dx \quad . \quad . \quad (28)$$

$$= \frac{l(\delta - \omega)}{E}dx - \frac{x(\delta - 2\mu\omega)}{E}dx \quad . \quad (29)$$

The cumulative elongation or stretch "s_1" from the top of the string to any point "x" along its length "l," taking into account lateral pressure as well as axial considerations, would be given by the integral of Equation (29) between the limits of zero and "x" thus,

$$s_1 = \int_0^x \frac{l(\delta - \omega)}{E}dx - \int_0^x \frac{x(\delta - 2\mu\omega)}{E}dx \quad . \quad (30)$$

$$= \frac{lx}{E}[\delta - \omega] - \frac{x^2}{2E}[\delta - 2\mu\omega] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

Furthermore, the cumulative elongation "s_2" along the length "l" from any point "x" to the bottom of the string is given by the integral of Equation (29) between the limits of "x" and "l" thus,

$$s_2 = \int_x^l \frac{l(\delta - \omega)}{E}dx - \int_x^l \frac{x(\delta - 2\mu\omega)}{E}dx \quad . \quad (32)$$

$$= \frac{l^2}{2E}[\delta - 2\omega(1 - \mu)] - \frac{lx}{E}[\delta - \omega] + \frac{x^2}{2E}[\delta - 2\mu\omega] \quad (33)$$

The addition of Equations (31) and (33) gives

$$s = \frac{l^2}{2E}[\delta - 2\omega(1 - \mu)] \quad (34)$$

and "S" now represents the total stretch over the entire length of a string of casing of length "l" freely suspended in a fluid of density "ω," where "δ" represents the density of steel and "μ" is Poisson's ratio. Equation (34) can also be obtained by letting "x" equal "l" in Equation (31), by letting "x" equal zero in Equation (33), or by the addition of Equations (14) and (27).

APPENDIX 2

Determination of Position of Neutral Point In a String of Casing Freely Suspended In Fluid

Consideration of the stress "σ_p" as defined by Equation (21) of Appendix 1 shows that it is a purely lateral stress and that its only effect is to cause

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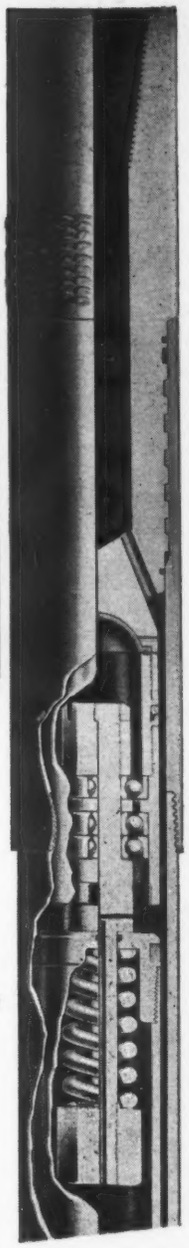

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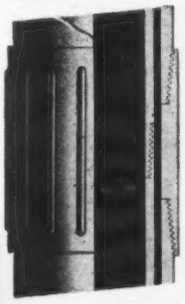

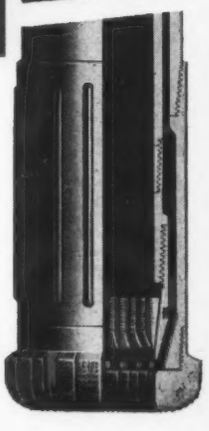

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an elongation of the string as shown by Equation (27). But since the lower end of the string is free to move, it simply extends the slight amount necessary to accommodate this stretch due to lateral pressure. As a result, no axial stress is developed as would most certainly be the case if the lower end of the string were fixed. The only manner in which stress conditions are altered by the extension due to lateral pressure is by an infinitesimal increase in the hydrostatic pressure acting on the lower end of the string. When considered with respect to the absolute pressure prevailing at the lower end, this increase is entirely negligible for all practical purposes.

Axial stresses, however, are of the utmost importance. For instance, from Equation (2) of Appendix 1 it can readily be seen that the tensile stress "σ_t" diminishes as we go from the top to the bottom of the string; while from Equation (5) it is also apparent that "σ_c," the compressive stress due to buoyancy, is independent of the position "x" of the element "dx" and is constant over the entire length of the string. At some point "x," therefore, "σ_c" must be just equal and opposite to "σ_t so that their net stress "σ_a" as defined by Equation (8) would be equal to zero thus,

$$\delta_a = l\ (\delta - \omega) - \delta\, x = 0 \quad . \quad (35)$$

or

$$\bar{x} = l\left(1 - \frac{\omega}{\delta}\right) \quad . \quad (36)$$

"$\bar{x}$" therefore is defined as the neutral point, or point of zero stress, subject to the limitations discussed above, i.e. considering the displacement of the neutral point by the effect of lateral pressure as negligible.

If now we substitute the value of "$\bar{x}$" from Equation (36) for "x" in Equation (31) we get,

$$\bar{s} = \frac{l^2\ (\delta - \omega)^2}{2E\ \delta}\left[1 + \frac{2\ \mu\omega}{\delta}\right] \quad (37)$$

in which "$\bar{s}$" represents the total elongation of the string in that portion of the length which is in tension above the neutral point.

Similarly substituting the value of "$\bar{x}$" from Equation (36) for "x" in Equation (33) we obtain,

$$\underline{s} = \frac{l^2}{2E}[\delta - 2\omega\ (l - \mu)\ ] - \frac{l^2\ (\delta - \omega)^2}{2E\delta}\left[1 + \frac{2\ \mu\ \omega}{\delta}\right] . \quad (38)$$

in which "$\underline{s}$" represents the total amount of shortening sustained by the portion of the string which is in compression below the neutral point.

Upon further examination, however, it will be found that the value of the second term of Equation (38) is almost identical with that of the first term, so that, for all practical purposes, the two terms cancel each other. As a matter of fact, if we had taken account of the increase in hydrostatic pressure due to the lengthening of the string by lateral pressure they would have been identical. This simply indicates that the effects of weight and buoyancy below the neutral point offset each other exactly so that the net deformation is zero.

The addition of Equations (37) and (38), of course, again results in the total amount of elongation "s" for the entire string as previously defined by Equation (34) of Appendix 1.

APPENDIX 3

Derivation of Equation for Stretch of Casing Suspended In Fluid and Fixed at Lower End

Consider a string of casing of total length "l" suspended from its upper end in fluid of density "ω" and fixed at its lower end.

Following the reasoning of Appendix 1, it can be shown that the tensile stress "σ_t" developed by the weight of the casing hanging below a point located a distance "x" from the top of the string would be,

$$\sigma_t = \delta\ (l - x) \quad . \quad . \quad . \quad . \quad . \quad . \quad (39)$$

where "δ" represents the density of the steel.

The net elongation or stretch "ds," then, of an element of length "dx" due to the hanging load only would be given by,

$$ds = \frac{\sigma_t}{E} dx \quad . \quad . \quad . \quad (40)$$

$$= \frac{\delta\ (l - x)}{E}\, dx \quad . \quad . \quad (41)$$

And the cumulative elongation "s_t" from the top of the string to any point "x," due to tensile stress only, would be given by the integral of Equation (41) from zero to "x" as follows:

$$s_t = \int_0^x \frac{\delta\ (l - x)}{E}\, dx \quad . \quad . \quad (42)$$

$$= \frac{\delta\ x(2l - x)}{E} \quad . \quad . \quad (43)$$

In view of the fact, however, that the casing is fixed at its lower end and, therefore, not accessible to the hydrostatic pressure developed by the column of fluid, there would be no force of buoyancy exerted against the lower end as was the case with the freely suspended string of Appendix 1.

On the other hand, however, the mere fact that the fluid is precluded from exerting an axial force on the pipe does not prevent it from subjecting the casing to the full effect of its application as a lateral pressure. Thus the elongation "ds" of the element of length "dx" due to the effect of lateral pressure would be the same as that given by Equation (24) of Appendix 1 or,

$$ds = \frac{2\ \mu\omega x}{E} dx \quad . \quad . \quad (24)$$

and the cumulative elongation or stretch "s_p" from the top of the string to any point "x" along its length "l" would be the same as that given by Equation (26) as,

$$s_p = \frac{\mu\omega x^2}{E} \quad . \quad . \quad . \quad (26)$$

By combining Equations (43) and (26) we obtain the expression,

$$s_t = \frac{\delta\ lx}{E} - \frac{x^2(\delta - 2\ \mu\omega)}{2E} \quad (44)$$

in which "s_t" represents the total elongation or stretch from the top to any point "x" along the length of a string of casing suspended in a fluid of density "ω" and fixed at its lower extremity, taking into account the effect of lateral pressure as well as tensile stress.

By substituting "l" for "x" in Equation (44) we obtain,

$$s' = \frac{l^2}{2E}[\delta + 2\ \mu\ w]. \quad . \quad (45)$$

in which "s'"represents the total elongation over the entire length "l" of string fixed at its lower end.

Scouts Given Oil Well

More than 15,000 Texas Boy Scouts and Girl Scouts are in the petroleum business, because local oil men drilled a well for them during a Scout fund raising drive. The well is a producer, so Boy Scouts in a 16-county area share a monthly income of $900, and Girl Scout troops receive $125 monthly.

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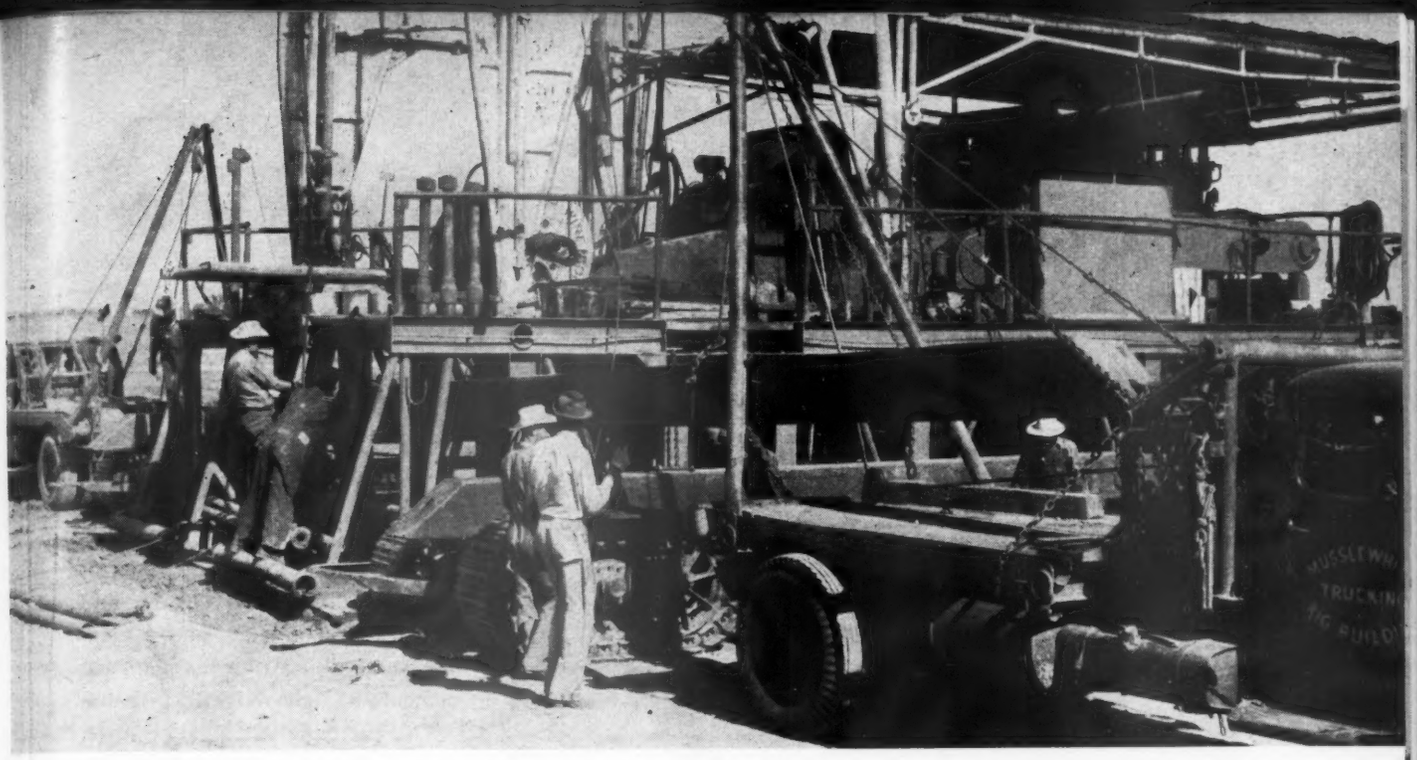

The rig building crew shown above is preparing to skid a rig from Lone Star Producing Company's McLaughlin No. 1 well to its McLaughlin No. 2 location in Scurry County. Beginning with bomber wheels, rig skidding crews graduated to the use of tractor wheels some three years ago when the bomber wheel tires caused too many delays due to blowouts.

P 422.13

Out of the War a New Method of Rig Skidding

Tractor wheels, heavy steel and timber beams, and 225-ton hydraulic jacks can help move a 400,000-lb rig more than 1000 ft in as little as 15 min.

CLARIBEL THOMPSON
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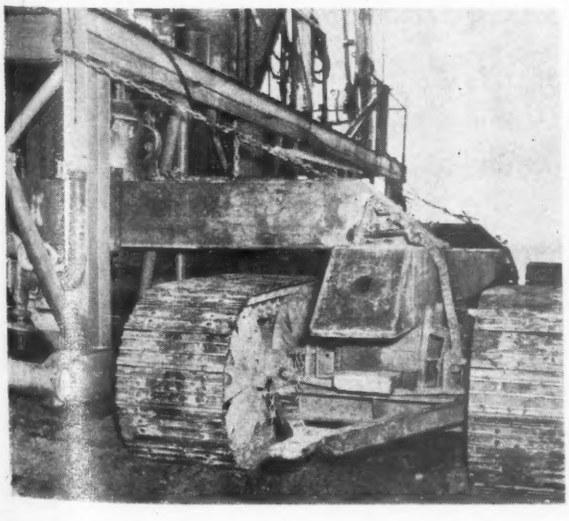
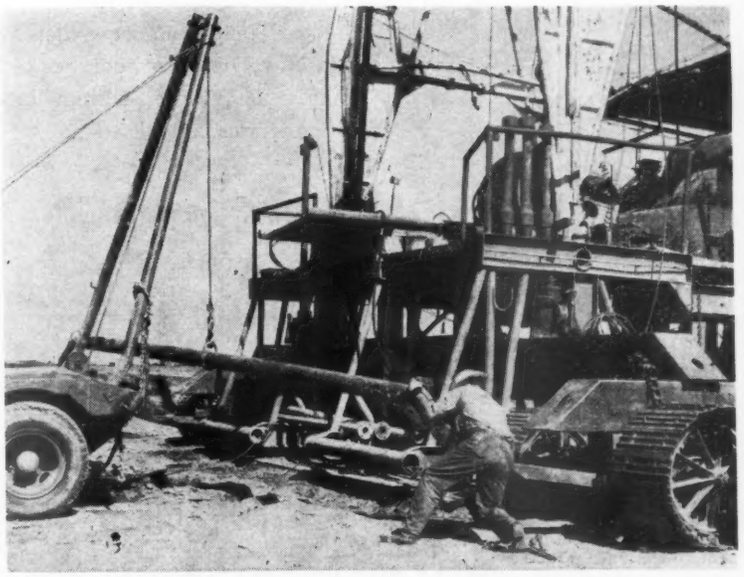
Closeup shows the double tractor wheels placed at each corner of the rig with side beams connecting front and back sets of wheels and cross beams set in place under the rig. Rig has already been lifted 8 in. from its planking by hydraulic jacks at each corner.





Tongue or "evener" is bolted into place on front tractor wheels by which the pulling will be done. It serves dual purpose of lining up front wheels and pulling device. Rig is moved without dismantling anything on the rig, except fuel and mud lines.

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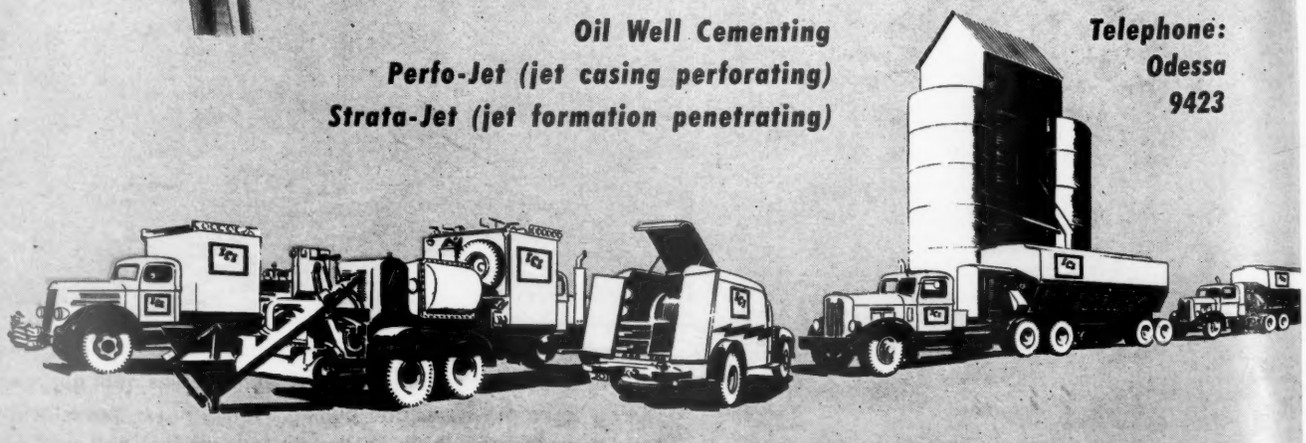
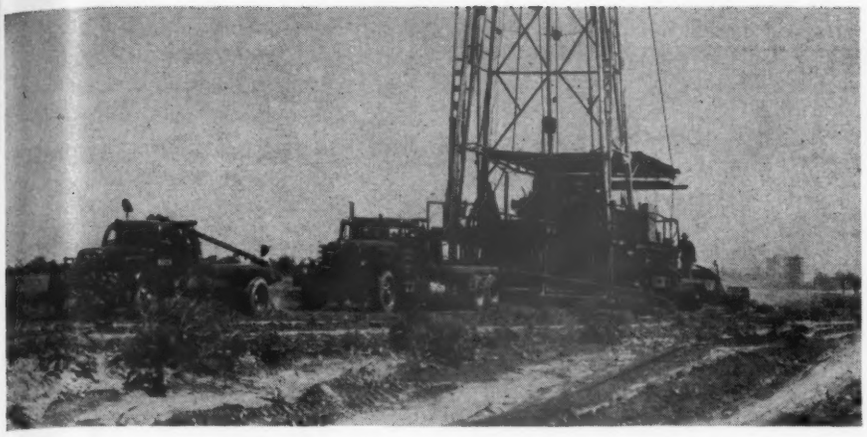
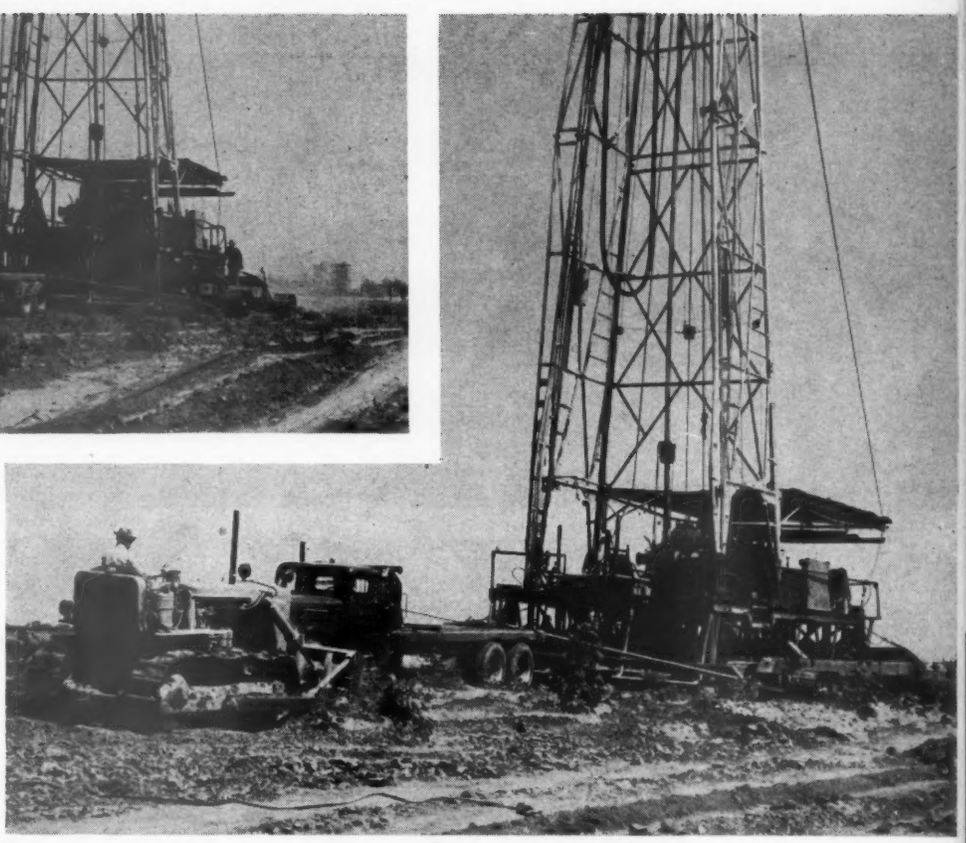




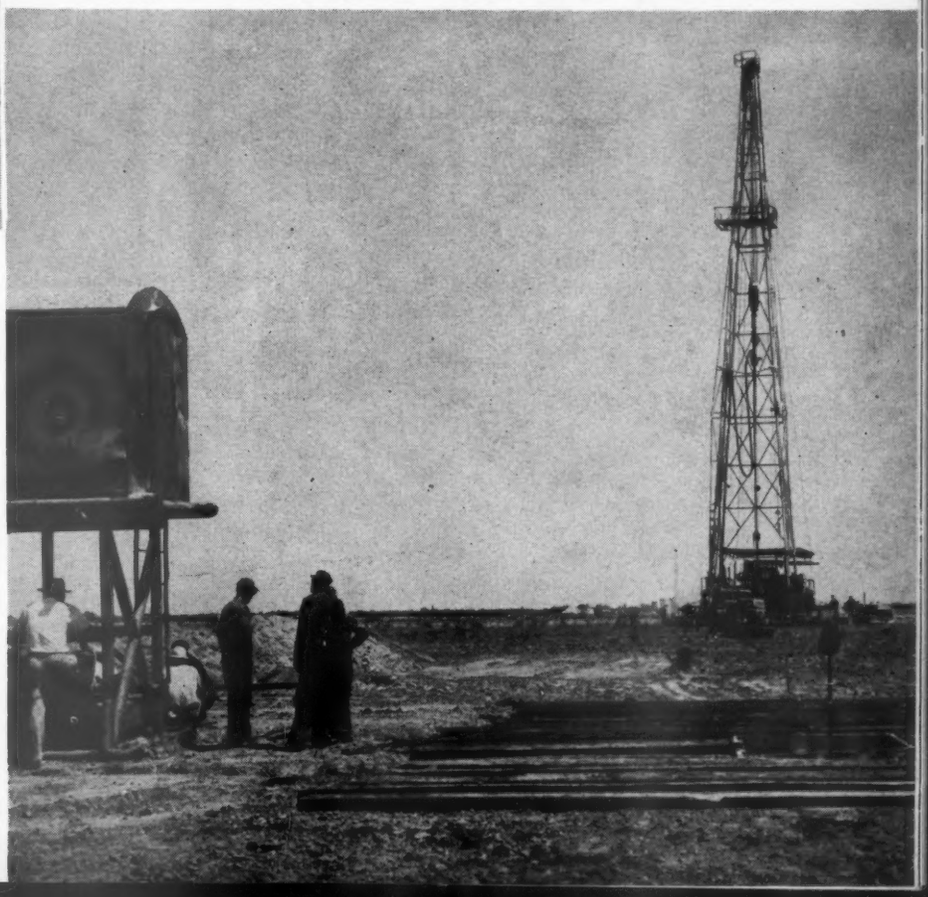
Moving begins as small winch truck serves as pilot and primer for big tandem, which does the heavy pulling. The small truck takes its stand ahead of the big truck, then, with back wheels braced and cable attached to front of big truck, helps the tandem move from a dead start. Cloud of dust behind rig shows trucks are moving.

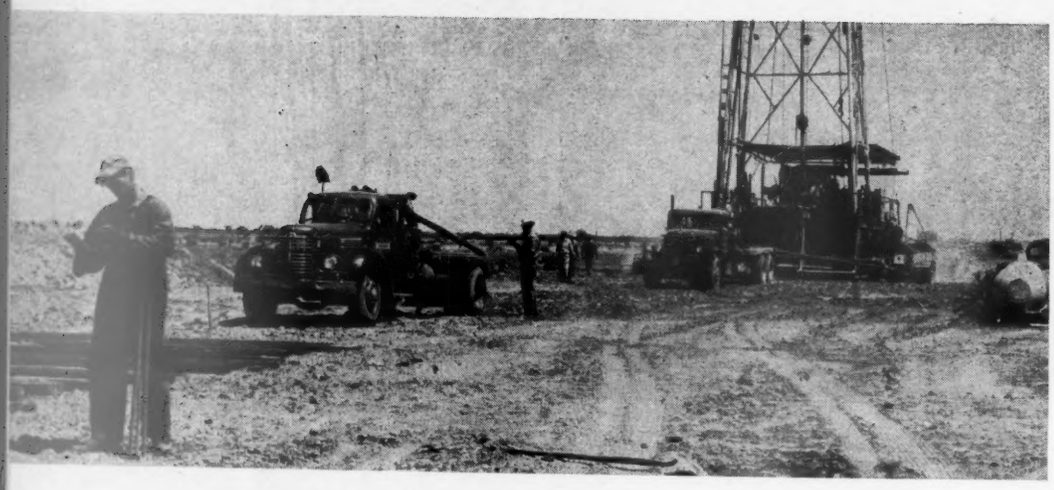


A stop because of high and uneven ground lengthens the moving time as a bulldozer is brought up to level off the steep embankment, which could have caused trouble. The moving crew men took this opportunity to eat their sack lunches on shady side of derrick.

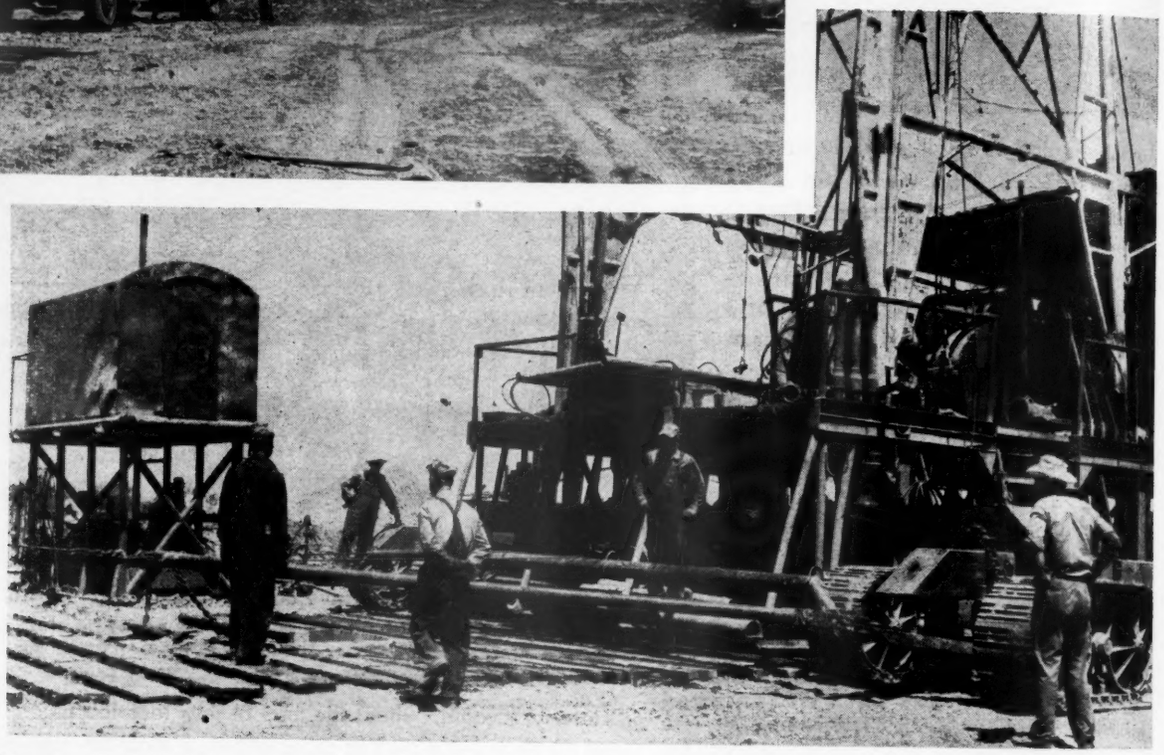
Busy bulldozer moves over to new location to clean excess dirt from circulating pit being readied for drilling of new well. Mud lines were already connected and ready for operation by the time the rig arrived. This work is done by drilling crew on tour during the moving. As soon as rig was in place, they began connecting mud and fuel lines so shutdown time would be cut to a minimum.

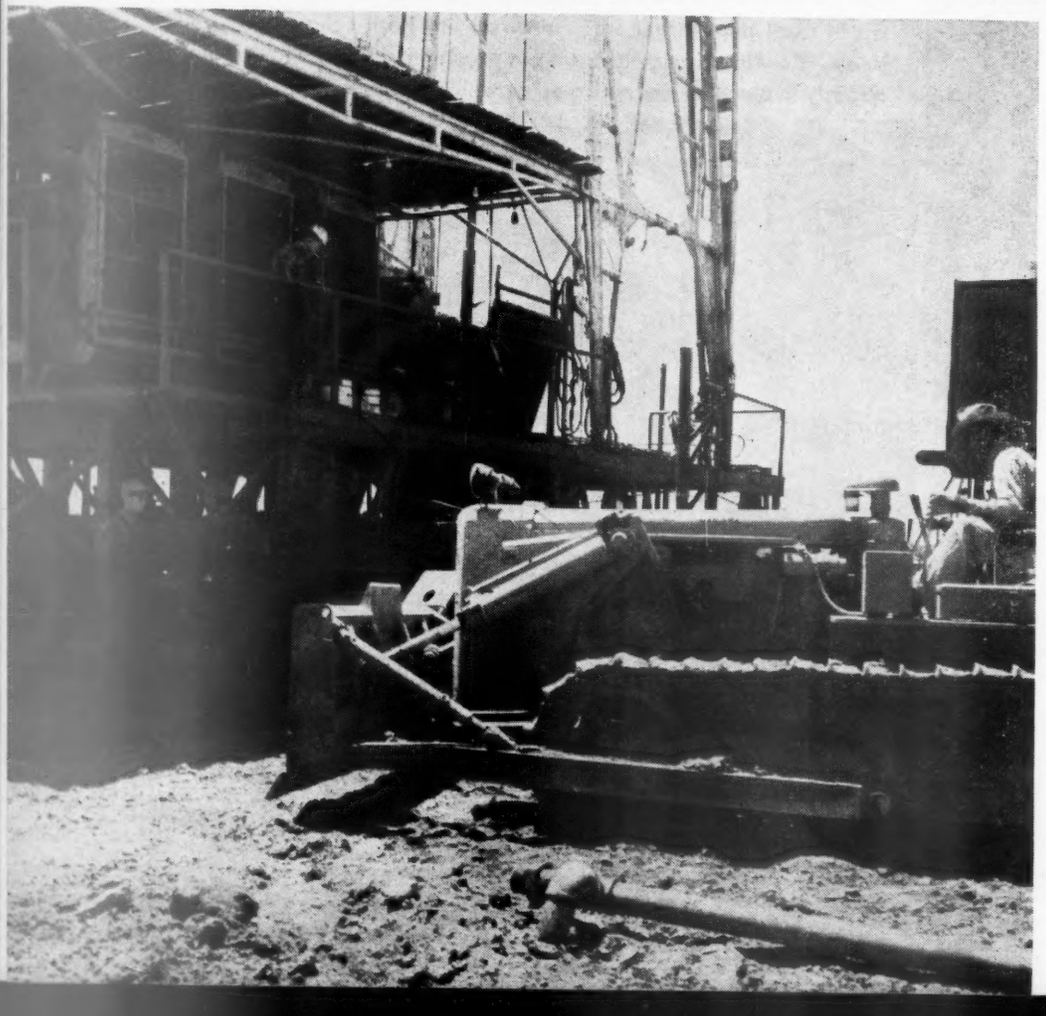
"Here they come," shout the men at new location as one hangs his cap on an upright stick in cellar at No. 2 location. Cap will help small winch truck pilot larger truck in direct line with cellar at No. 2. Heavy planking, removed from old location after rig moved out, is already in place as well as rig office which was moved by smaller truck.





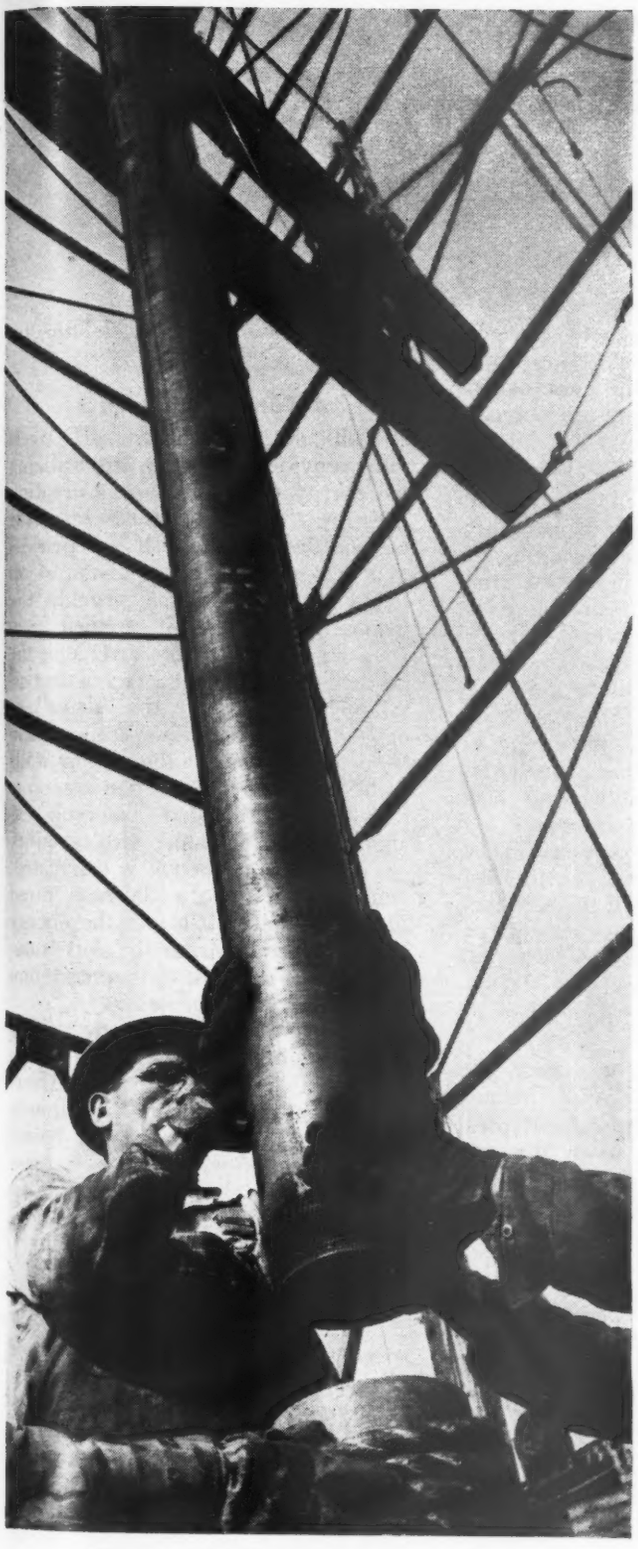
Pilot truck veers slightly to assure accurate run over target. Once the rig pulls up over the flooring it is difficult to maneuver it so that drill table and cellar are in direct line, unless the approach is made accurately.





Tractor wheels creak forward as trucks exert pull to the right on evener to make derrick floor line up with new location cellar. Here in final stages of skidding, as in advance preparation, precision is essential to complete job in contract time of 8 hr. Rig skidding began at 8 a.m. that morning. New well was spudded 7 hr later. Advantage is moving with drawworks intact.

Final push is exerted by busy bulldozer, which moves rear tractor wheel at slight angle so last pull by big tandem truck will put rotary table in direct line with cellar. Even before this work was completed, drilling crew was busy connecting fuel lines and warming up big Waukesha engines for the spudding of new well.



"These threads show no sign of loosening..."

—says a Texas drilling supt.

● "Experience has proved to me that these threads show no sign of loosening even after a long period of time," said this Texas drilling superintendent. He made his observation after watching the setting of a string of 7-inch H-40 Republic Electric Weld Casing, and the completion of the well with 2⅞-inch H-40 Republic Electric Weld Tubing.

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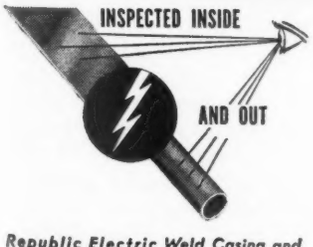

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More Wells—More Oil†

H. H. KAVELER*

PART 1

No oil pool can be produced a second or third time. A pool drilled, developed and depleted with one well to each 10 surface-acres cannot be restored to its native state and produced again to determine if one well to each 20-acres or some other spacing would result in ultimately the same, or more, or less, oil recovery for the pool. The industry is denied the opportunity of repeating the production operation to have directly comparative experience as a means of learning whether the ultimate recovery from a pool is in any way dependent solely on the number of wells drilled. The ordinary procedure of experimental science cannot be followed. For that reason, an indirect deduction from known fact and logical premises must be relied upon in appraising the problem.

Nevertheless, it is a matter of great importance to the nation, to the petroleum industry and to every owner of rights in an oil pool to know if there is a greater or less recovery of petroleum from any pool depending upon whether a greater or less number of wells are drilled. Do "more wells produce more oil?" Are "oil reserves lost" because only one well is often drilled to each 40-acres rather than 2 or 4 wells to the 40-acres? These particular questions have been before the industry a long time and have been answered by competent petroleum engineers in a number of excellent publications over the past fifteen years.[1] The engineering conclusion is that other elements in the exploitation of any pool are determinative of the ultimate oil recovery; the number of wells drilled is not.

In spite of the long established engineering conclusion, persistent efforts are continued by some who seek to propagate the myth that "more wells produce more oil." They are the advocates of "close" well-spacing. Those who would like to believe the myth of close-spacing of wells, or who would like for others to believe it, are driven to the defensive cry that the logic of petroleum engineering fact is too theoretical for the (self-styled) "practical" man, and that the conclusions drawn from technology are not confirmed by experience.

What, then, is experience? Those who advocate the drilling of many wells have never published comprehensive field histories pointing to specific examples where, in the operation of actual pools, the recovery of oil from a pool was greater because a greater number of wells were drilled. Heroic addresses on the "expert" witness-stand is the usual forum for expounding generalized conclusions, alleged experiences, and purported scientific fact by those who advocate dense drilling as the necessary and essential step to the recovery operation. If experience is to be the ultimate test of fact, then, if there be fact, the advocates of close well-spacing should utilize opportunities to lay the full fact of experience before the industry. What does the history of oil pools reveal?

The purpose of this paper is to present production statistics and related facts concerning 6 pools as typical examples of among more than 50 pools that have come to notice and study. In each instance, the number of wells in the pool have been increased by either in-fill drilling or extension drilling. These are examples of pools that have been developed since production statistics and sub-surface information records have been kept with sufficient accuracy and detail to permit conclusions respecting the relationship between ultimate recovery and number of wells drilled in a *pool*. The distinction between "pool" and "field" is important to logical conclusion. A pool is considered to be a single common source of supply. A field may consist of one or more pools.

If others will attempt further analysis and refinement of the data to be presented, or undertake to search the records to establish other examples, the effort in preparing this paper will be considered worthwhile. If experience is to be the final count, then an effort to throw the mythical experience of the advocates of close well-spacing into true light can be an important contribution to the advancement of the conservation practices of the industry.

A Fundamental Fact

Wells do not produce oil! Wells only provide the means for utilizing the energy of production by creating pressure "sinks" to drain reservoir energy and to establish the process that brings about the expulsion of oil from rock. Wells also provide the means whereby the oil expelled from rock can be lifted to the surface of the earth. The fundamental fact is that oil is produced only by the "drive" of expanding gas or water from within the reservoir rock to the well or wells drilled into the rock. When reservoir pressure is exhausted—reservoir energy is exhausted—and with certainty —petroleum production is exhausted. Only that number of wells are required in a pool that will utilize the energy of production beneficially. Any number of wells in excess of that minimum number are wasteful wells.

Ultimate recovery of petroleum is not substantially dependent upon the total number of wells drilled. Reservoir pressure maintenance is the only means for increasing ultimate recovery, and dense drilling or an increase in number of wells is in no manner an effective substitute for pressure maintenance.

How Many Wells Required?

While a general discussion of well-spacing is not the primary purpose of this paper, it may be useful, for discussion of the field data to be presented, to restate the principles established by petroleum engineering technology in respect to the number of wells that should be drilled into any pool. That number of wells should be drilled into any *common source of supply* that are necessary to:

1. Define the extent of the pool and the limits of production.
2. Insure that every segment of the pool productive of petroleum is penetrated by at least one well.
3. Insure sufficient wells, after consideration to geological and reservoir characteristics of each pool, to permit the maximum beneficial use of either natural or artificial sources of reservoir energy.

†Presented at the Spring Meeting of the Mid-Continent District API Division of Production, Skirvin Hotel, Oklahoma City, Oklahoma, March 29-31, 1950.

*Assistant to Vice President, Production Department, Phillips Petroleum Company, Bartlesville, Oklahoma.

[1]References in Part 2.

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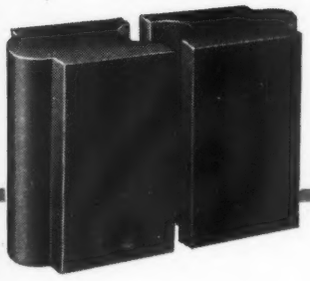

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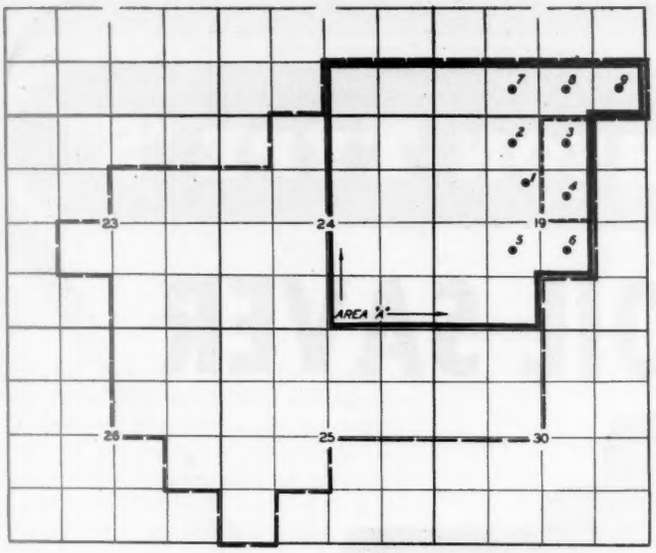


FIG. 1

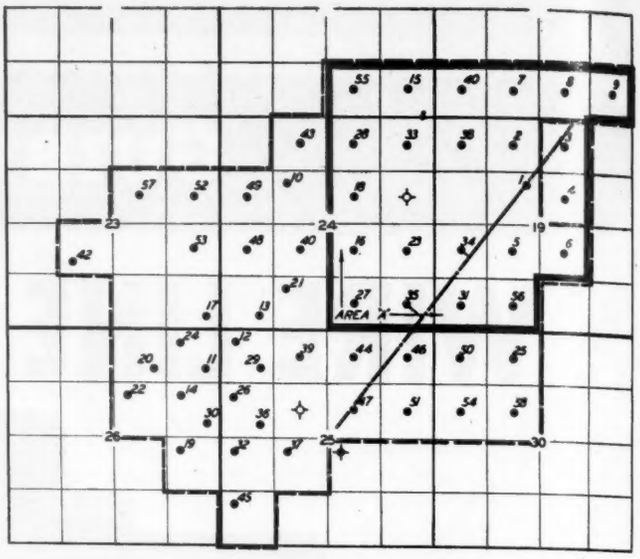


FIG. 3

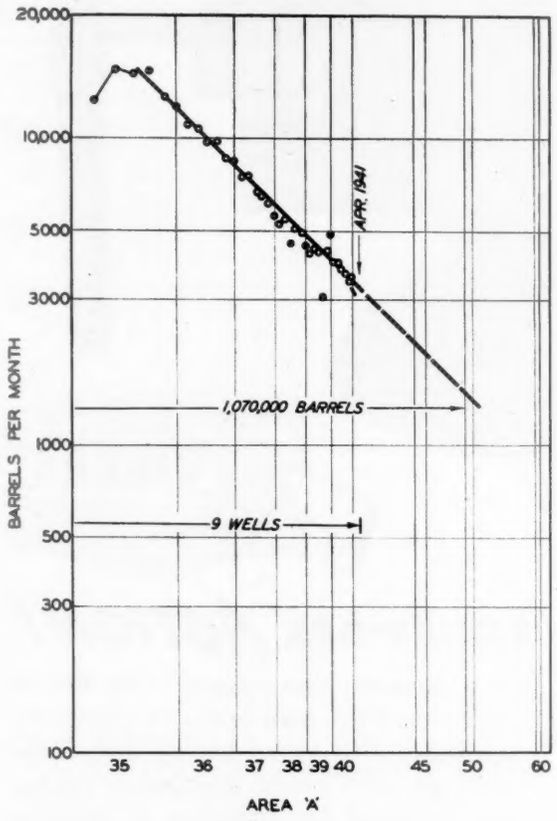


FIG. 2

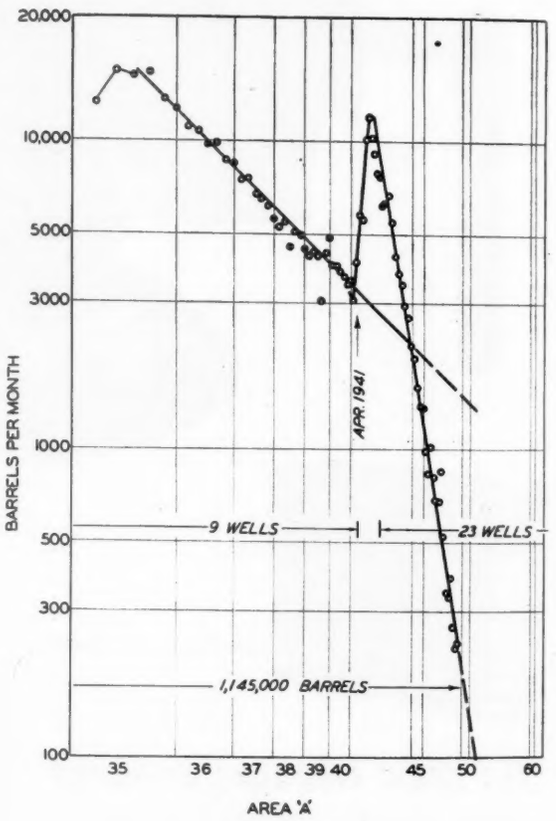


FIG. 4

4. Insure sufficient numbers of wells to maintain productive capacity at rates equal to or in excess of market demand for petroleum.

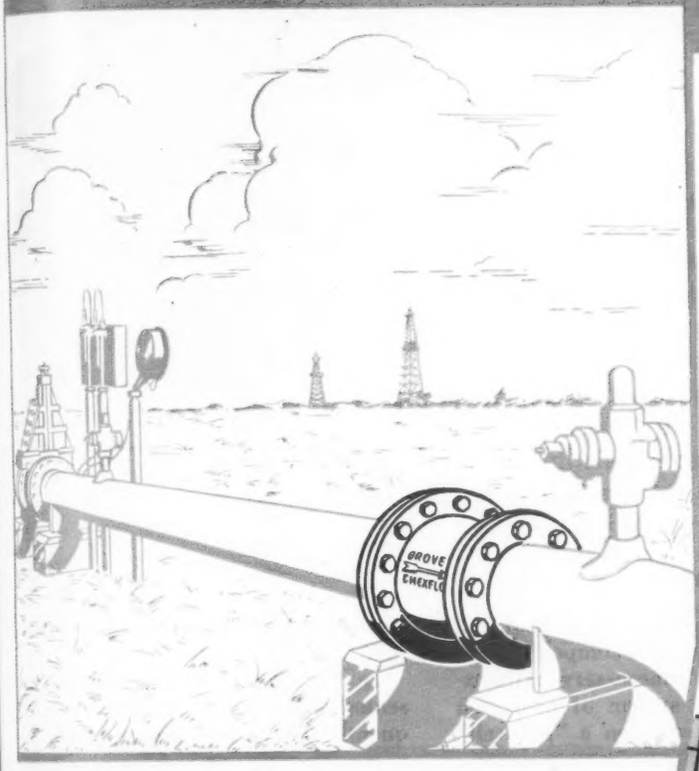
These principles, based on sound technical fact, obviously do not fix the well-spacing at one well per 10-acres nor at any other density. They do not stand against the notion that the number of wells alone determines the ultimate recovery from a pool. The extent to which they are adopted depends upon the many circumstances arising from regulatory practices and policies existing in the various states that are taken into consideration in reducing any technical principle to practice.

"Close-Spacing" Myth

The notion that "more wells produce more oil" has wide appeal to laymen. Many so-called "experts" are always willing to tell a client what the client likes to hear. The average layman falls victim to the close-spacing myth often as a result of one or more of the following misconceptions:

1. That wells on separate tracts are the only means for an owner of a separate tract to share in the production from a common source of supply.

GROVE CHEXFLO CHECK VALVES



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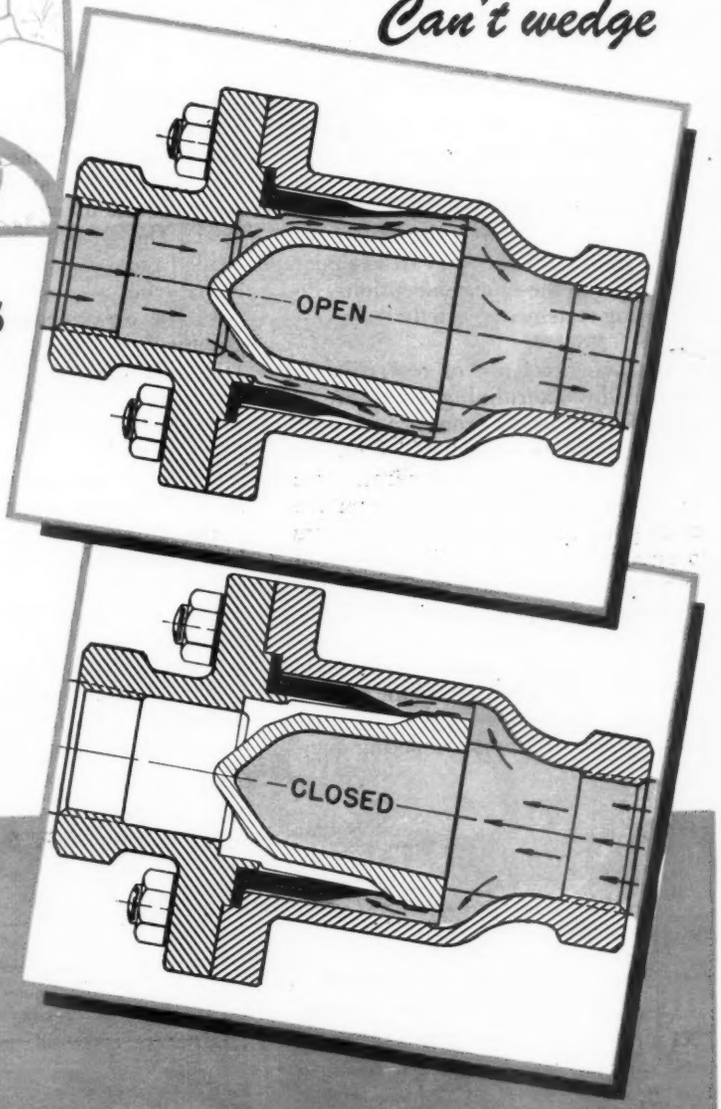

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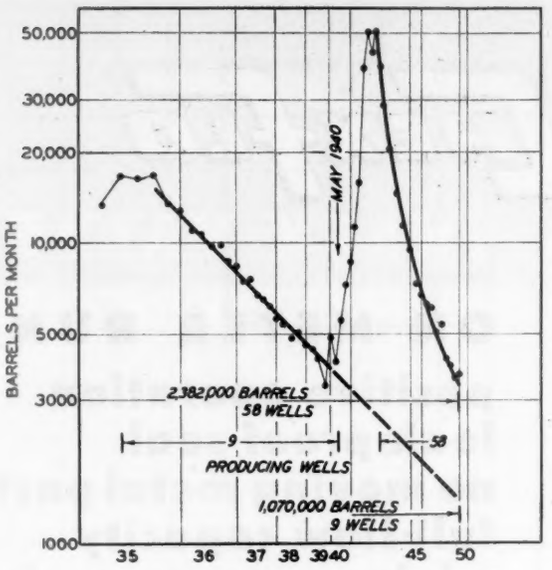


FIG. 5

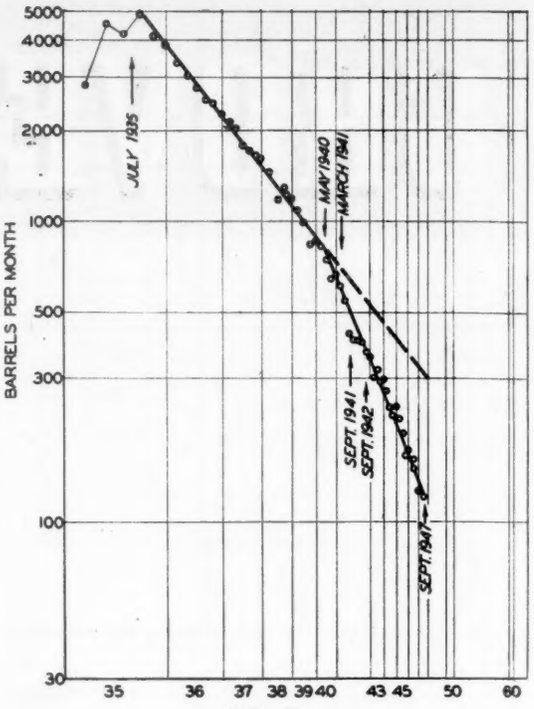


FIG. 7

2. That the mere drilling of a well or wells on a separate tract will insure the owner of his "fair" share from a common source of supply.
3. That the drilling of equi-distant offsets or equal density of wells is an act which in itself will protect a tract against drainage.
4. That the more wells drilled the greater the recovery from a pool.

In respect to these misconceptions, the following statements, briefly made, apply:

The beneficial use of reservoir energy is the determining factor in establishing recovery from a pool. Any well drilled into a pool drains oil not alone from beneath the separate lease on which it is drilled, but from the entire pool. The production that comes to any well or lease may or may not be a surface owner's fair share of the production from the entire pool. The amount of production from any separate lease is determined in large part by the allocation formula if the pool is prorated, and in large part by the conduct of offsetting and competing owners in their recognition of the correlative rights of others. A compelling reason for drilling unnecessary wells exists whenever a system of proration allocates oil to wells on a "per-well" basis. The separate lease most densely drilled recovers ultimately the greater share from a common source of supply. The only means for maximizing the recovery from a pool and for obtaining a fair distribution of the pool production to each separate owner is through the established system of unit operation.

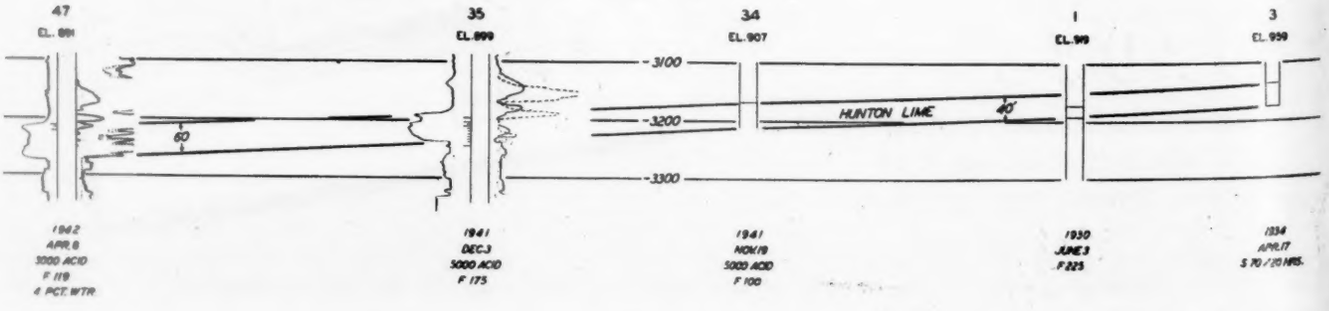
The close-spacing myth is the folklore of those in possession of incomplete, unrecorded, and unwritten history of pools. In the absence of recorded fact, experience becomes legendary and occurrences are recalled from the vague and hazy past, involving instances where an additional well produced an astonishing amount of oil that would not otherwise have been recovered. Such legend is poor evidence in resolving the question of well-spacing.

In the course of the studies presented in this paper, attention was frequently directed to the reported "initial potentials" of in-fill or extension wells drilled in old pools. Many in-fill drilled wells, which by "recollection of the expert," had a potential of 1000 bbl per day, actually had, upon investigation of its production records, no higher monthly production than the average of offsetting and older wells, even in the first month of production. Or investigation when records were sufficient to permit an investigation showed that the astonishing well was completed in a reservoir or separate pool theretofore undrilled.

Conclusions Supported

The history of fields drilled and produced at various densities of wells where records have been kept with sufficient accuracy to permit analysis

FIG. 6



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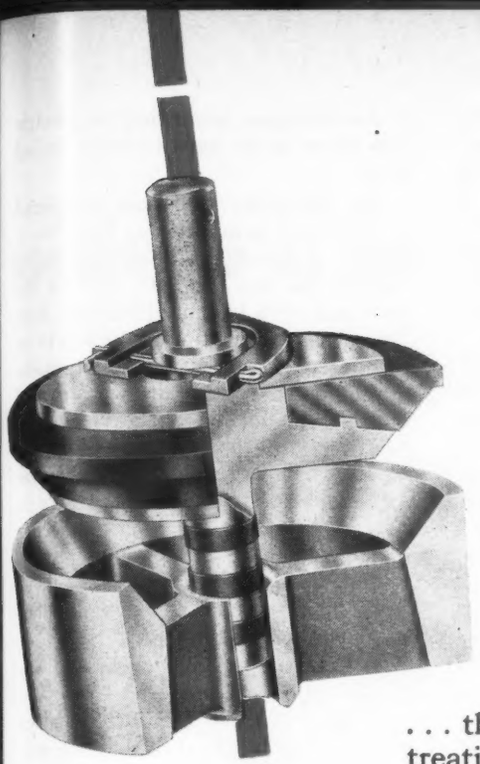

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establishes the following general conclusions:

1. A well has the capacity to drain an area of a common source of supply much larger than the area attributed to its drilling or spacing unit.

2. The capacity to drain a large area of a common source of supply occurs in limestone reservoirs as well as in sandstone reservoirs.

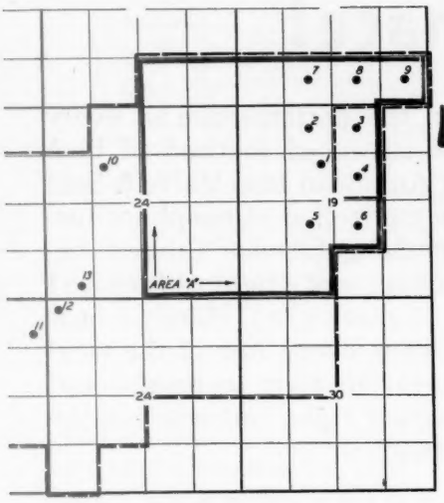

FIG. 8

3. Increased numbers of wells may often cause a decrease in ultimate recovery of oil if increased numbers of wells result in excessive depletion of reservoir energy by drilling into gas-caps or high gas-oil ratio areas of a pool, or, by drilling into the water table with resultant excessive production of water in a water-drive pool.

4. For the greatest ultimate oil recovery, sufficient wells must be drilled to penetrate every productive segment of a pool, and the distribution of wells should be such as to define the pool, and, to utilize the energy of production with maximum benefit.

5. Cutler's Rule expresses an empirical relationship for determining the amount of oil that may be captured or drained from the entire common source of supply by separate leases drilled to different well densities.

Hotulke-West Earlsboro

This pool is in Township 9 North, Range 4 and 5 East, Pottawatomie County, Oklahoma. The Hunton Limestone production occurs at a depth of 4100 ft and has from 50 to 60 ft of gross thickness according to electric logs taken in the most recently drilled wells.

The discovery well was completed in 1930 and is marked as Well No. 1 on Fig. 1, which figure also shows by dashed line the ultimate area of the pool and by a hachured line an Area "A" whose production history is to be compared before and after complete development. Nine wells were drilled on 40-acre spacing by the year 1935. These 9 (original) wells had a production history to the end of the year 1940 reflected by the decline curve on Fig. 2. Extrapolation of this decline curve indicates that the recovery to the year 1950 would have been 1,070,000 bbl. The nine wells were first classified as the "West Earlesboro Pool."

In May, 1940, Well No. 10 was drilled about 1¼ miles to the West and Well No. 11 was drilled about two miles to the West of the nine wells to develop what later proved to be a southwest extension of the pool (Fig. 3). In the area of Well No. 11 there followed the drilling of 16 wells on 20-acre spacing, which development was classified as "Hotulke—20-acre spacing." The remainder of the area around Well No. 10 was classified as "Hotulke—40-acre spacing." The production history of the pool is difficult to follow because of the separate pool designations. Ultimately, all of the production was found to be from one common source of supply, fully developed as shown by Fig. 3.

To the North of the area is other Hunton Limestone production. The tier of quarter-quarter sections lying to the North of the Hotulke-West Earlsboro Hunton Limestone was never drilled. An absence of any effec-

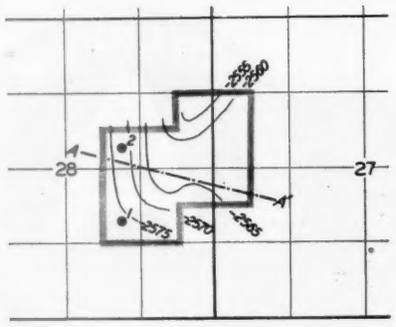

FIG. 9

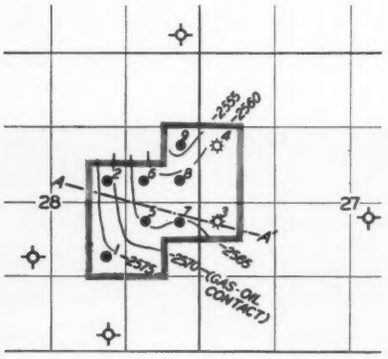

FIG. 11

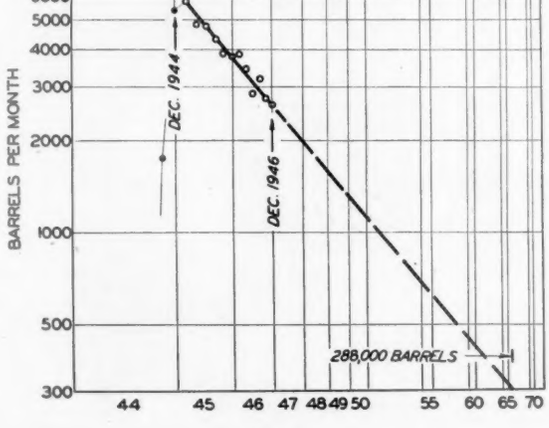

FIG. 10

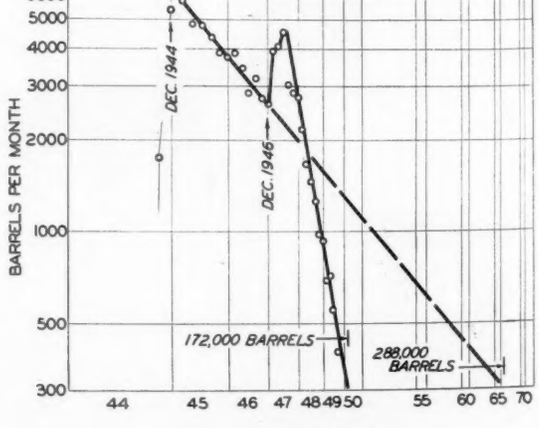

FIG. 12

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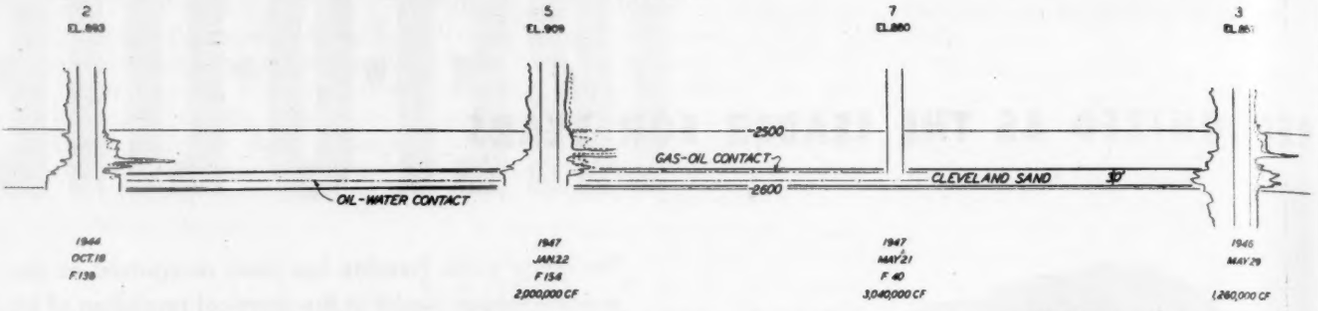
T-50-4

FIG. 13



tive communication between the two areas is indicated. A few wells produced from the Viola and Wilcox formations and a small adjustment to obtain actual production from the Hunton was necessary.

The dry hole to the Southeast of the center of Section 25 was drilled and completed in August, 1949, for 7 bbl per day and abandoned after one month's production. In January, 1950, a well was drilled one-quarter mile west of Well No. 42 in the NW SW SW Sec. 23. Although this well extended the productive limits beyond that shown by the dashed line, its low initial production of 35 bbl per day indicates that it will not produce enough oil to affect the conclusions here drawn.

This pool is an example of extension drilling. Attention might be first directed to the original nine wells and their production history in conjunction with the production of the Area marked "A". Area "A" comprises 1000 acres and was fully developed on 40-acre spacing in 1941-1942 with 14 additional wells, a result of the drilling of extension well No. 10. Area "A" with 23 wells produced to the year 1950 only 1,145,000 bbl as shown by actual production statistics, Fig. 4. This recovery compares with an estimated recovery of 1,070,000 for the original 9 wells to the same date had no additional development occurred. Four of the 6 unplugged wells which remain in Area "A" are near an economic limit, whereas the 9 wells alone would have had at this time a substantial future recovery.

The drilling of the 14 additional wells produced no substantial amount of additional oil to the credit of Area "A". More wells did not produce more oil.

Obviously, too, the original 9 wells were draining an area larger even than Area "A". The 14 wells gave the usual peak in production followed by the usual accelerated decline. Advocates of close well-spacing would give considerable attention to the temporarily increased rate of production but little attention to the accelerated decline that inevitably followed. The important fact here, however, is that the comparison of recovery is made in respect to January 1, 1950. The deed is done and Area "A" has in hand substantially no more oil than was recoverable through the original 9 wells, had no further development taken place throughout the pool.

The decline curve for the entire pool, Fig. 5, leads to the interesting observation that the 58 wells drilled in the pool had recovered as of January 1, 1950, a total of 2,382,000 bbl. Only 12 wells remain as producers. Wells 32 and 37 have had an exceptional life in that together they still produce 100 bbl per day. The decline curve of the original 9 wells indicates, without much room for dispute, a recovery to January 1, 1950, of 1,070,000 bbl, a recovery of almost 50 per cent for 9 wells *clustered at one extremity* of the pool, of that obtained by 58 wells.

This example illustrates the necessity for defining and drilling the entire common oil supply, and it illustrates that wells are capable of draining from a large portion of any common supply. Had the 9 wells been drilled over the entire pool rather than at one extremity, they would have recovered as of January 1, 1950 substantially more than 50 per cent of the recovery of the 58 wells.

Fig. 6 is a cross-section to establish the general characteristics of the pool and to emphasize the fact that this is a limestone reservoir of ordinary limestone characteristics. While some might admit the sufficiency of wide spacing in sandstone reservoirs, there has always been a reluctance to accept wide spacing in limestone reservoirs. Here the technical conclusions in respect to wide spacing fit the performance of a typical limestone reservoir as well as they do sandstone reservoirs.

Cut Corrosion Costs

Formaldehyde is now used in America's oil fields to counteract hydrogen sulfide corrosion. The manufacturer says the new technique results in a saving of $29 on equipment replacement for every $1 invested in the chemical.

Well Interference

The capacity of wells to drain large areas of a pool is no better established than by demonstration of the interference as between wells in a common source of supply. For this purpose, the production history of the two wells, Nos. 3 and 4, in the Hotulke Pool can be used. The production of the two wells is shown on Fig. 7 with a peak of 80 bbl per-day-per well and following for five years a normal decline. In the months after the completion of Well No. 10, drilled as a 1¼ mile extension of the producing area in May, 1940, a point of accelerated decline is indicated. By March, 1941, when Well No. 13 had been completed, Fig. 8, interference with Wells 3 and 4 was quite evident, even though these wells were more distant than 1¼ miles. In the month of March, 1941, Well No. 10 was producing at an average rate of 2500 bbl per month and the total production from Wells 10, 11, 12 and 13 was at the rate of 8400 bbl per month. At the same time the original 9 wells were producing at the rate of 3100 bbl per month.

The pool was defined by the 58 wells in September, 1942, at which time Wells 3 and 4 had an established accelerated decline on the log-log scale of Fig. 7, which decline continued to the abandonment of Wells 3 and 4 in September, 1947. There is little reason to doubt the conclusion that Wells 3 and 4 absent additional drilling beyond the original 9 wells would have drained substantially more oil from distant parts of the reservoir.

Southeast Warwick

This pool is in Township 14 North, Range 3 East, Lincoln County, Oklahoma, where the Cleveland Standstone occurs at a depth of about 3500 ft and has about 30 ft of thickness.

The discovery well in this pool was completed in October 1944 with an initial production by natural flow of 138 bbl per day and is marked Well No. 1 in Fig. 9. Hachured lines indicate the area ultimately developed by drilling. Well No. 2 was drilled as a 40-acre offset in December, 1944, for an initial potential of 94 bbl per day. There was no further development for

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the following 1½ years. The 2-year production history of the two wells is shown on Fig. 10, which curve extrapolated to a production of 300 bbl per month or to about the year 1966 indicated an ultimate recovery of 288,000 bbl.

The next well drilled in the pool was a gas well completed in May 1946 with an initial potential of 1,260,000 cu ft per day. It was situated some 2000 ft distant from the discovery well and is marked Well No. 3 on Fig. 11. There followed then the drilling of Well No. 4 as a north offset to Well No. 3, completed as a gas well in October 1946 with a capacity of 8,000,000 cu ft per day.

Thereafter, Wells 5, 6, 7, 8, and 9 were drilled on 10-acre locations intervening between the initial 2 oil wells and the 2 gas wells. The characteristics of these wells and their initial production were as follows:

Well No.	Oil, bbl/day	Gas, cu ft/day	Gas-oil ratios cu ft/bbl	Oil gravity API
2	94	?	?	54
6	38	?	?	....
8	25	1,500,000	60,000	54
9	10	500,000	50,000	....
1	138	?	?	42
5	154	2,000,000	13,000	32.5
7	40	3,040,000	76,000	57

The drilling established that a gas-oil contact existed at approximately —2570 ft. The gas from the 2 gas wells was marketed for a time and records indicate that a volume of only 421 million cu ft were sold. No records are available of the gas produced from the wells classified as oil wells, although it is obvious from their initial gas-oil ratios that they produced substantial volumes of gas.

The production curve for the pool after complete development is shown in Fig. 12. With additional drilling after December 1946 the pool exhibited the usual increase in production rate followed by an accelerated decline, which was unquestionably due to the production of gas not alone from the 2 gas wells in the gas-cap, but also from the high gas-oil ratio wells drilled at or above the gas-oil contact of the pool. The ultimate recovery from the pool as shown by the production history almost to the point of abandonment is only 172,000 bbl, substantially less than normally would have been expected from the original 2 wells. Only 4 wells are unplugged at this time. More wells did not produce more oil because the additional wells resulted in wasteful use of gas-cap energy.

The cross-section shown in Fig. 13 indicates the continuity of the Cleveland Sand.

Part 2 will be published soon.

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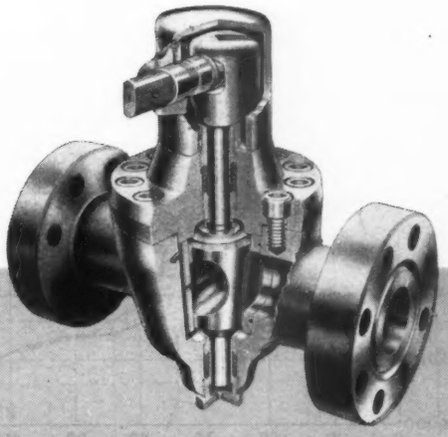

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The Use of Tubing as Drill Pipe†

W. F. BATES

As an integral part of the continuous effort to reduce well costs, the Pacific Coast area staff of Shell Oil Company undertook a study of slim hole drilling. These studies were conducted to determine optimum hole and drill pipe sizes and included such factors as circulating rates and pressures, mud flush, rising velocity and availability of suitable sidewall sampling, fishing and testing tools. Because theoretical and practical considerations were strongly in favor of the 6¾-in. hole using 3½-in. drill tubes, this combination was accepted as a basis for slim hole operation.

Studies of possible drilling units that could be moved legally over California highways led to the conclusion that equipment designed to handle 10,000 ft of 3½-in. drill pipe did not exist and furthermore that it was extremely unlikely such equipment could or would be built for some time; however, it was recognized that existing portable equipment could be used to drill deeper, if the drill pipe loads could be reduced. Further studies along this line, which included a review of our experience with Acme-thread drill casing used for drilling in the Ten Section field, led to the selection of 9.3 lb 3½-in. upset J-55 API tubing with Acme-type threads for the drilling of 6¾-in. slim holes.

A portable drilling unit powered with a 150-hp diesel engine was available for testing the practicability of using tubing for drilling and it was reasoned that as this unit could suc-

†Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, California, May 11 and 12, 1950.

The Author

W. F. Bates is a drilling engineer for Shell Oil Company, Los Angeles, California. He received his AB from Stanford University in 1934. Beginning work with Shell immediately after graduation, he has completed various engineering assignments at Long Beach, Ventura, and Bakersfield. For the last 5½ years he has been stationed in Shell's Los Angeles office, concerned solely with drilling problems.

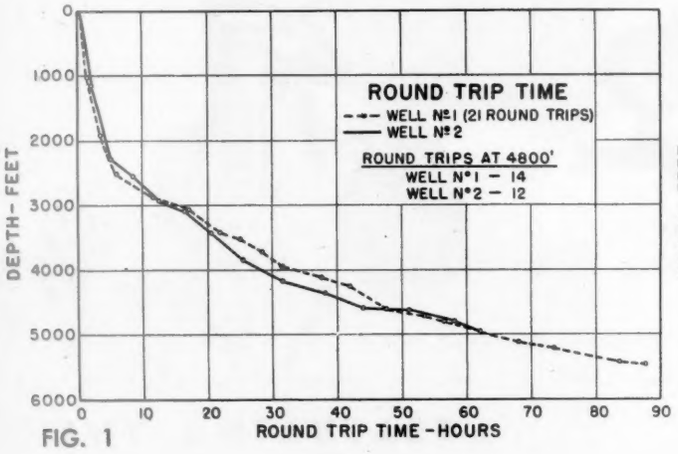


FIG. 1

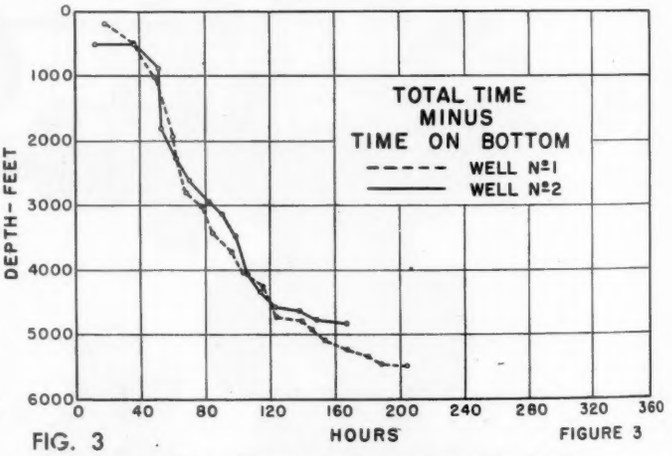


FIG. 3 FIGURE 3

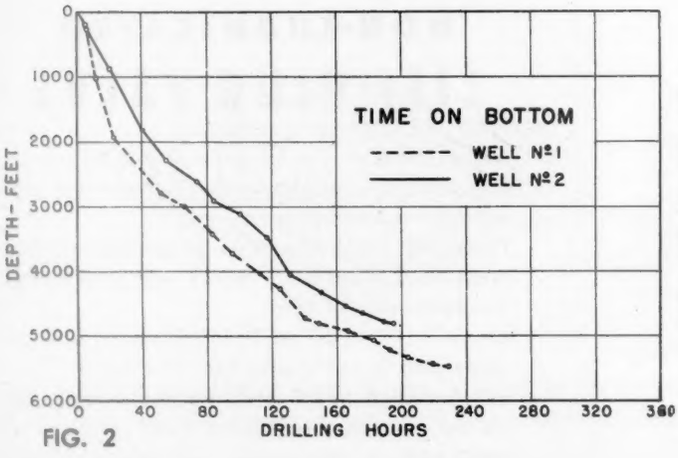


FIG. 2

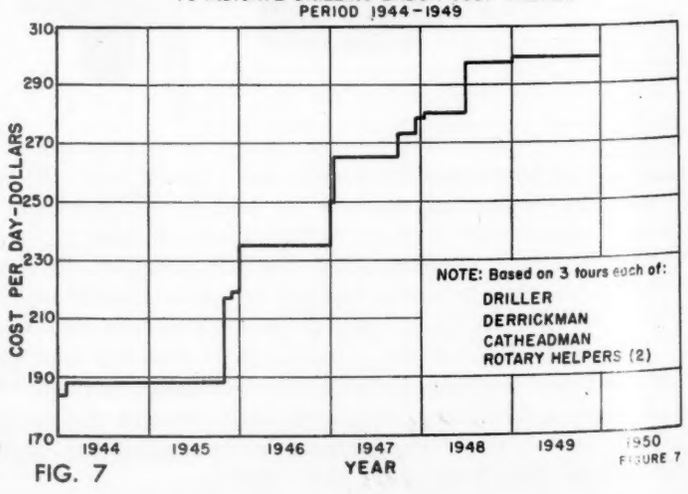


FIG. 7 FIGURE 7

FIG. 4

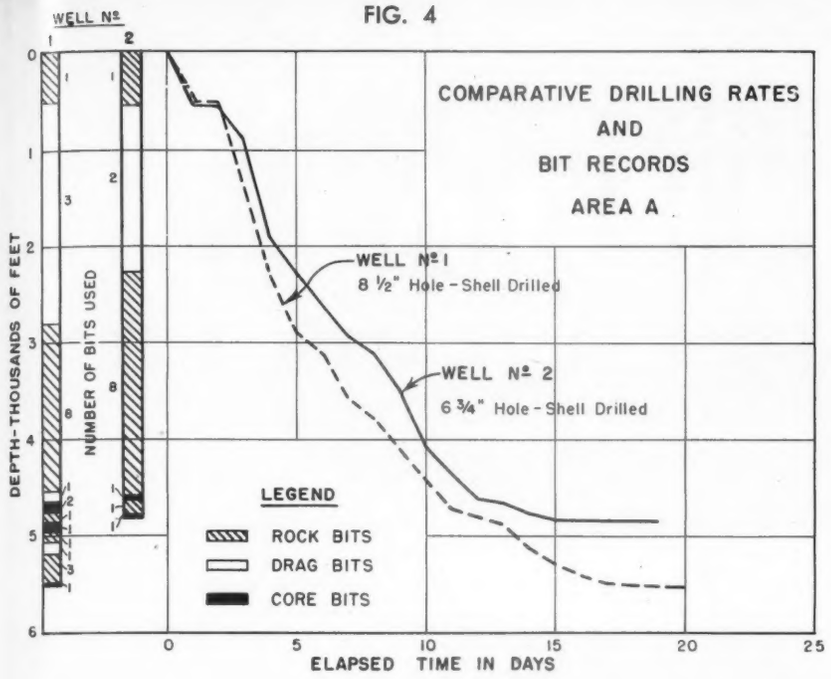
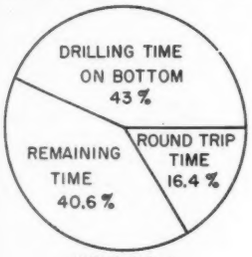
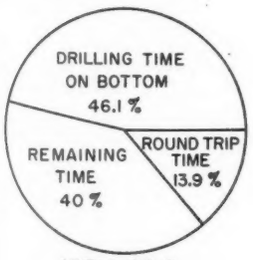


FIG. 5

COMPARISON OF VARIOUS PERCENTAGES OF TOTAL RIG TIME



WELL NO. 1
(to 4800 ft.)
8½" Hole Shell Drilled



WELL NO. 2
6¾" Hole Shell Drilled

cessfully handle loads equivalent to 3500 ft of 4-in. 16.6-lb drill pipe, its depth range could be extended to 6500 ft through the use of 9.3-lb tubing as drill pipe.

The selection of 9.3-lb tubing was based primarily upon availability of an API standard tube plus the fact that 2½-in. tubing had been successfully used in "drilling in" operations in the Ten Section field. Therefore, it was believed this tubing would have the ability to transmit the necessary torque required for rock bit drilling. "J" grade tubing was preferred over "N" grade as it has more resistance to shock as indicated by elongation specifications.

Acme-type threads were selected because they have been used so successfully in our drill casing operations in the Ten Section field and also because this type of thread could be obtained without waiting for the manufacture of special joints. Also, it was believed that an inexpensive tool joint such as a tubing collar, if it could be used, would contribute materially to the economic success of slim hole drilling. As experience with drill casing had definitely proved (a) the desirability of using power tubing tongs to spin up the pipe as it is run in the hole and (b) the necessity of using specially built tong jaws which would evenly distribute over a large area the crushing force developed while breaking out the tubing, this equipment was obtained before starting the drilling test.

As circulating rates and pressures were expected to be well within the rating of the pumps normally used with the 150-hp drilling unit, no alterations or additions were made to this equipment.

Area "A" in the San Joaquin Valley was the location for our initial tubing-drilled hole. A conventional well had been drilled in this area in 1945 which it was believed would offer a yardstick for comparing progress. The tubing-drilled hole was completed in 1946. A detailed cost comparison indicated that when allowances were made for the estimated rise in material and labor costs, the saving was about $2.00 per foot, or about 30 per cent.

In addition to this favorable cost comparison, a study of other factors such as round-trip time (Fig. 1), time on bottom (Fig. 2), total time minus time on bottom (Fig. 3), drilling rates and bit records (Fig. 4), as well as a comparison of various percentages of total time (Fig. 5) indicated that the slim hole and lightweight pipe combination was comparable to the large hole and heavy pipe combination.

Although direct well cost comparisons are exceedingly unreliable, it is fortunate that since the drilling of the initial tubing-drilled hole in 1946 there are 4 other areas in which detailed cost comparisons can be made. In 2

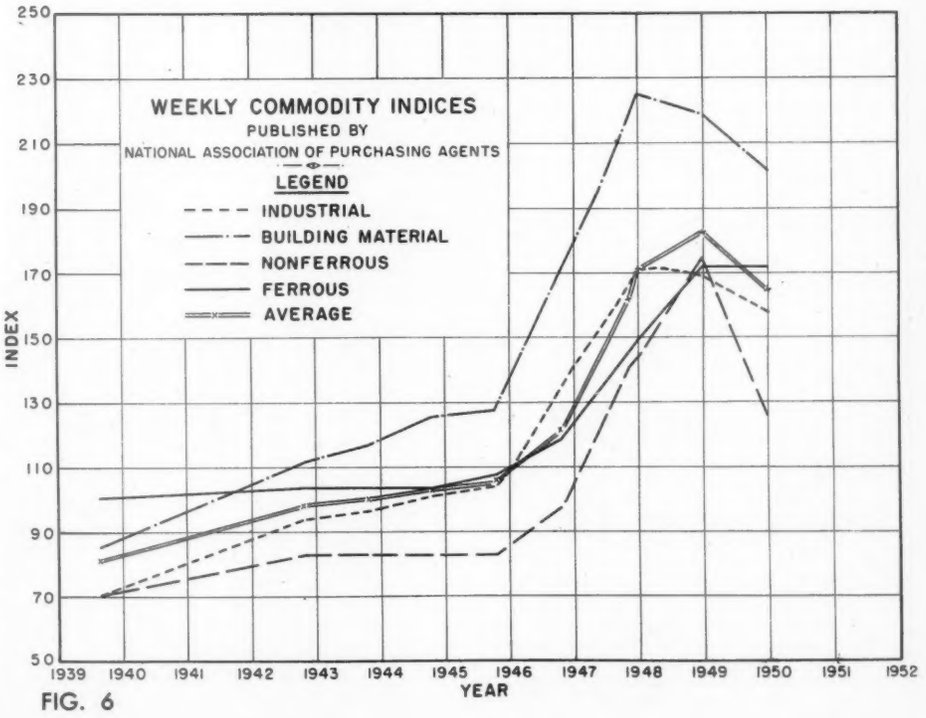


FIG. 6

TABLE 1

COMPARISON OF WELLS DRILLED WITH TUBING AND DRILL PIPE

Area	Well No.	Completion Date	Total Depth (Feet)	Number of Days to Total Depth	Comparable Depth for Group (Feet)	Number of Days to Comparable Depth	Well Costs Actual (Dollars)	Group Adjusted Well Costs (Dollars)	Cost Per Foot Actual (Dollars)	Group Adjusted Cost Per Foot (Dollars)	Daily Operating Costs (Dollars)	Daily Operating Costs Adjusted (Dollars)	Number of Days Completing	Number of Days Testing and Abandoning	Hole Size (Inches)	Casing Size (Inches)	Tubing or Drill Pipe (Inches)	Contract or Shell
A	1	5-30-45	5,485	18	4,825	12	32,669	39,602	5.96	7.22	712	...	...	2	8-1/2	...	4-1/2 D.P.	S
A	2	6-18-46	4,825	15	4,825	15	26,252	26,252	5.44	5.44	735	...	...	4	6-3/4	...	3-1/2 T.	S
B	3	1-28-45	5,162	57	1,827	11-1/4	67,872	...	13.15	...	...	846	...	3	8-1/2	...	4-1/2 D.P.	C
B	4	4-16-45	1,827	15	1,827	15	14,300	...	7.83	...	...	449	...	3	6	...	3-1/2 D.P.	S
C	5	12-29-46	3,350	9	3,350	9	43,797	51,056	13.07	15.24	...	939	9	...	7-5/8	5-3/4	3-1/2 T.	S
C	6	1-14-47	3,350	7	3,350	7	30,257	34,440	9.03	10.28	763	...	6	...	7-5/8	5-3/4	3-1/2 T.	S
C	7	1-28-47	3,400	6	3,350	5-3/4	28,517	33,310	8.39	9.83	661	...	9	...	7-5/8	5-3/4	3-1/2 T.	S
C	8	4-8-47	3,400	8	3,350	7	35,390	38,257	10.41	11.25	1,142	...	3-1/2	...	8-1/2	5-3/4	3-1/2 D.P.	C
C	9	2-2-48	3,500	5	3,350	4-3/4	32,725	32,725	9.35	9.35	1,479	...	5	...	8-1/2	5-3/4	3-1/2 D.P.	C
D	10	6-30-44	7,006	80	5,000	37-1/4	110,983	165,814	15.84	23.42	988	1,300	...	2	10-5/8	...	4-1/2 D.P.	C
D	11	6-13-47	5,000	37	5,000	37	53,040	53,040	10.61	10.61	861	861	...	1	6-3/4	...	3-1/2 T.	S
E	12	2-5-46	5,528	22	5,118	21-1/2	110,856	138,928	20.05	25.10	1,338	1,910	36	...	8-1/2	5-3/4	4-1/2 D.P.	C
E	13	10-4-46	5,238	22	5,118	20	54,876	67,627	10.48	12.95	664	869	12	...	6-3/4	4-3/4	3-1/2 T.	S
E	14	3-3-47	8,493	64	5,118	36	122,615	128,880	14.44	15.13	926	1,081	23	...	8-1/2	5-1/2	4-1/2 D.P.	C
E	15	4-25-47	5,300	16	5,118	15-1/2	64,839	67,908	12.23	12.80	1,542	1,736	8	...	8-1/2	5-1/2	4-1/2 D.P.	C
E	16	6-9-47	5,118	15	5,118	15	72,098	75,386	14.09	14.70	1,435	1,561	...	12	8-1/2	5-1/2	4-1/2 D.P.	C
E	17	7-11-47	5,195	17	5,118	16-1/2	55,471	57,445	10.68	11.40	1,818	1,920	...	7	8-1/2	...	4-1/2 D.P.	C
E	18	8-18-47	5,300	16	5,118	14	29,028	29,986	5.48	5.65	696	718	...	2	6-3/4	...	3-1/2 T.	S
E	19	10-12-47	5,629	18	5,118	15	55,952	55,952	9.94	9.94	715	715	...	17	6-3/4	4-3/4	3-1/2 T.	S
F	20	12-2-46	3,720	7	...	...	42,842	...	11.52	...	720	...	...	20	6-3/4	4-3/4	3-1/2 T.	S
G	21	10-31-47	1,763	6	...	...	24,185	...	13.72	...	1,017	...	...	3	6-3/4	...	3-1/2 T.	S
G	22	1-6-48	4,887	54	...	...	77,082	...	15.77	...	842	...	...	6	6-3/4	...	3-1/2 T.	S
H	23	8-2-48	10,319	205	...	...	225,605	...	21.86	...	...	875	...	1	6-3/4	...	3-1/2 T.	S

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TABLE 1 - Continued

Area	Well No.	Completion Date	Total Depth (Feet)	Number of Days to Total Depth	Comparable Depth for Group (Feet)	Number of Days to Comparable Depth	Well Costs Actual (Dollars)	Group Adjusted Well Costs (Dollars)	Cost Per Foot Actual (Dollars)	Group Adjusted Cost Per Foot (Dollars)	Daily Operating Costs (Dollars)	Daily Operating Costs Adjusted (Dollars)	Number of Days Completing	Number of Days Testing and Abandoning	Hole Size (Inches)	Casing Size (Inches)	Tubing or Drill Pipe (Inches)	Contract or Shell
I	24	12-29-48	6,140	40	5,135	19	89,390	...	13.58	...	985	...	5	...	8-5/8	5-9/16	4-1/2 T.	S
I	25	3-30-49	5,940	17	5,135	12	57,416	...	9.67	...	1,049	...	7	...	8-5/8	5-1/2	4-1/2 T.	S
I	26	6-1-49	5,500	18	5,135	16	44,277	...	8.05	...	965	...	...	5	8-5/8	...	4-1/2 T.	S
I	27	2-16-48	5,275	15	5,135	14	54,604	...	10.35	...	1,117	...	7	...	8-5/8	5-1/2	4-1/2 D.P.	S
I	28	4-8-49	6,180	26	5,135	13	81,965	...	13.26	...	1,172	...	2	...	9-5/8	7	4-1/2 D.P.	S
I	29	6-29-49	6,090	25	5,135	15	78,422	...	12.88	...	1,167	...	6	...	9-5/8	7	4-1/2 D.P.	S
J	30	12-5-48	4,805	21	3,300	7	...	...	...	...	...	...	...	...	9-5/8	7	4-1/2 T.	S
J	31	7-2-49	4,522	19	3,300	7	...	...	...	...	...	...	...	...	9-5/8	7	4-1/2 T.	S
J	32	8-22-49	5,000	32	3,300	8	...	...	...	...	...	...	...	...	9-5/8	7	4-1/2 T.	S
J	33	10-13-49	4,892	32	3,300	12	...	...	...	...	...	...	...	...	9-7/8	7	4-1/2 T.	S
J	34	5-2-47	5,110	20	3,300	11	...	...	...	...	...	...	...	...	8-5/8	5-9/16	4-1/2 D.P.	S
J	35	6-17-47	4,750	12	3,300	6	...	...	...	...	...	...	...	...	8-5/8	5-1/2	4-1/2 D.P.	S
J	36	9-21-47	4,350	22	3,300	11	...	...	...	...	...	...	...	...	8-5/8	5-1/2	4-1/2 D.P.	S
J	37	5-27-48	4,095	12	3,300	8	...	...	...	...	...	...	...	...	8-5/8	5-9/16	4-1/2 D.P.	S
K	38	11-21-49	5,350	...	...	...	...	...	...	...	...	...	...	...	(11 (7-5/8	8-5/8	4-1/2 T.	S
L	39	8-25-49	5,210	11	...	...	47,921	...	9.15	...	1,008	...	6	...	8-5/8	5-1/2	4-1/2 T.	S

of these areas only one tubing-drilled hole and one large hole were drilled. In another area, 5 wells were drilled; 2 of these wells were drilled by contractors and the other 3 by Shell using 3½-in. tubing as drill pipe. In the remaining area, 8 wells were drilled of which 3 were tubing-drilled holes, and the other 5 were drilled with contract tools using 4½-in. drill pipe and drilling an 8½-in. hole.

Even in areas known to be fairly comparable in drilling rates, it is difficult to directly compare well costs, particularly in wildcat or semi-wildcat drilling. This is further complicated owing to the rapid increase in material and labor cost which took place in 1945, 1946 and 1947. In Table 1 an attempt has been made to compare costs through the use of a commodity index chart (Fig. 6). This chart was prepared with the aid of the purchasing department and must be used with caution as no attempt was made to ascertain the exact per cent increase of detailed items. However, each accounting classification was analyzed for per cent of tangible material cost and applicable commodity index and an adjustment made. All intangible costs including outside labor were adjusted in accordance with the labor index chart (Fig. 7). Costs are adjusted only for the time increment from the drilling of the first to the last well in any one group. In this manner, it is believed that a truer difference in cost of tubing-drilled hole versus conventional hole is obtained. Table 2 gives an example of the technique employed to analyze and adjust costs in accordance with the commodity indices.

The wells drilled in Area "E" offer the best comparative data as they are the most numerous as well as the most recent. Again caution must be exercised in directly comparing these adjusted well costs because in some instances wells were abandoned without setting casing while others were abandoned after setting casing and still others were completed as producing wells. Additionally, various numbers of days were consumed in making tests before completing or abandoning.

A recapitulation of the wells drilled in Area "E" necessitates their division as shown in Table 3. This recapitulation indicates that wells drilled in this area with Shell tools using tubing as drill pipe saved an average of about $6.00 per foot. It should be stated that Well 15 was a consecutive well for the contractor whereas Shell Well 13 was the first Shell-drilled well in the area and required moving equipment about 400 miles.

Also of interest is the average com-

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parable daily operating cost in this area for the small rig using tubing as drill pipe and a larger contract rig (adjusted for wage and material differences by multiplying actual daily operating cost times per cent increase of average commodity indices as plotted in Fig. 6), the former being $767 per day and the latter $1647 per day, or a difference of $880 per day. For comparative purposes this difference should be reduced by $110 per day as tool depreciation is not included as a cash operating cost on Shell rigs.

As a further check on tubing-drilled holes, the daily rate of progress for each well was plotted by areas, (Area "B"—Fig. 8, Area "C"—Fig. 9, Area "D"—Fig. 10, Area "E"—Fig. 11). Area "E" again offers the best data. It is extremely interesting to note that in this area a 6¾-in. tubing-drilled hole penetrated to the area's comparable depth of 5118 ft in 14 days. Three other wells reached this depth in 15 days, one of which was a tubing-drilled hole. In 17 days another 8½-in. hole reached this depth followed by a tubing-drilled hole in 20 days, the latter being the first tubing-drilled hole in the area. The two holes which made the slowest progress were 8½ in. in diameter; one was the discovery well and the other had a 15-day fishing job.

A recapitulation of adjusted well costs in the other two comparable areas is shown in Table 4.

Differences in depths of the wells in Area "D" make direct cost comparisons difficult but it is of interest that the tubing-drilled hole reached its maximum depth of 5000 ft in 37 days at a daily operating charge of $860 whereas the conventional hole reached 5000 ft in 37¼ days with a daily operating charge of $988 ($1300 adjusted).

Adverse weather encountered in drilling the first tubing-drilled hole in Area "C" (Well 5) resulted in its cost being higher than normal.

In addition to the wells already mentioned, Table 1 shows the results of drilling 3 other wells with 3½-in. tubing, the most interesting of which is a 6¾-in. hole that was carried to a depth of 10,319 ft. Needless to say, this well was carried deeper than originally anticipated but it illustrates the ability of the 3½-in. tubing and the Acme-thread joints to take punishment.

Before starting the deep well, a 16,920-ft string of 3½-in. Acme-thread drill tubing with collars was purchased at a cost of $12,819, or about $0.755 per foot. At the completion of this well (202 days drilling), approximately 1850 ft of tubing had been retired which has a salvage value of 50

TABLE 2. Adjustment of costs according to commodity indices.

Area "E"— Well No. 12 | Date completed: 2-5-46 | Total Depth: 5328 feet

Item	Total cost (dollars)	Index used*	Index values: At date of drilling well	Index values: At date of last well drilled in group	Increase (per cent)	Adjusted cost (dollars)
Labor	86,717	W	235	285	21.2	105,101
Service facilities	401	A	111	161	45	581
Tool rental	292	A	111	161	45	423
Drilling materials and supplies	7,243	A	111	161	45	10,502
Rig foundation	306	B	134	214	59.6	488
Cementing material	1,057	B	134	214	59.6	1,687
Mud material	4,065	N	88	139	51	6,138
Casing	7,335	F	112	132	30	9,536
Production equipment	3,440	F	112	132	30	4,472
Totals	110,856					138,928
Cost per foot	20.05					25.10

* Indices according to Fig. 6:
A—Average
I—Industrial
B—Building material
N—Non-ferrous
F—Ferrous
W—Wages (crew costs) in accordance with Fig. 7

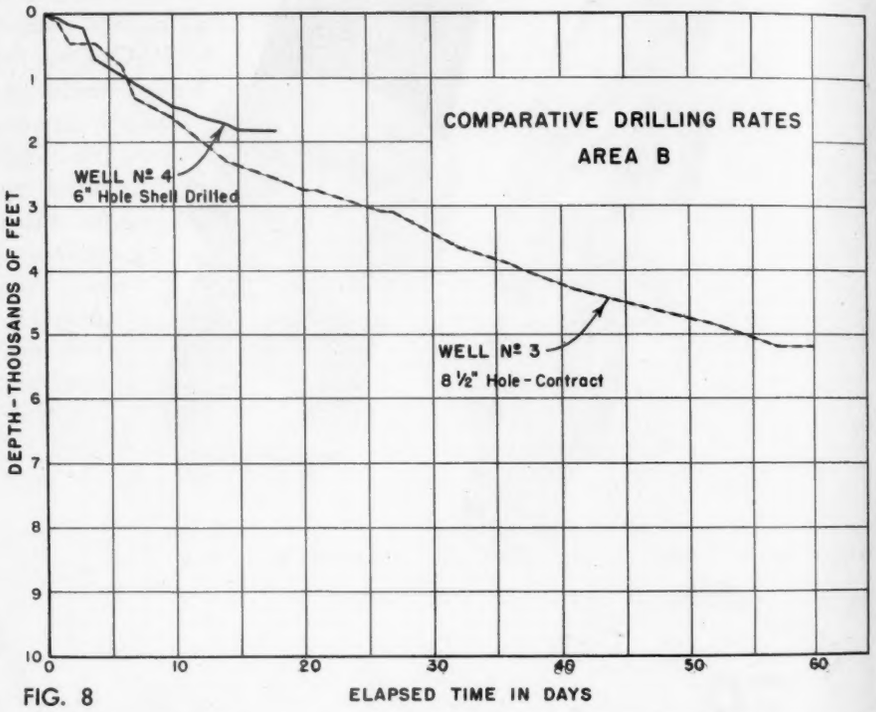

FIG. 8

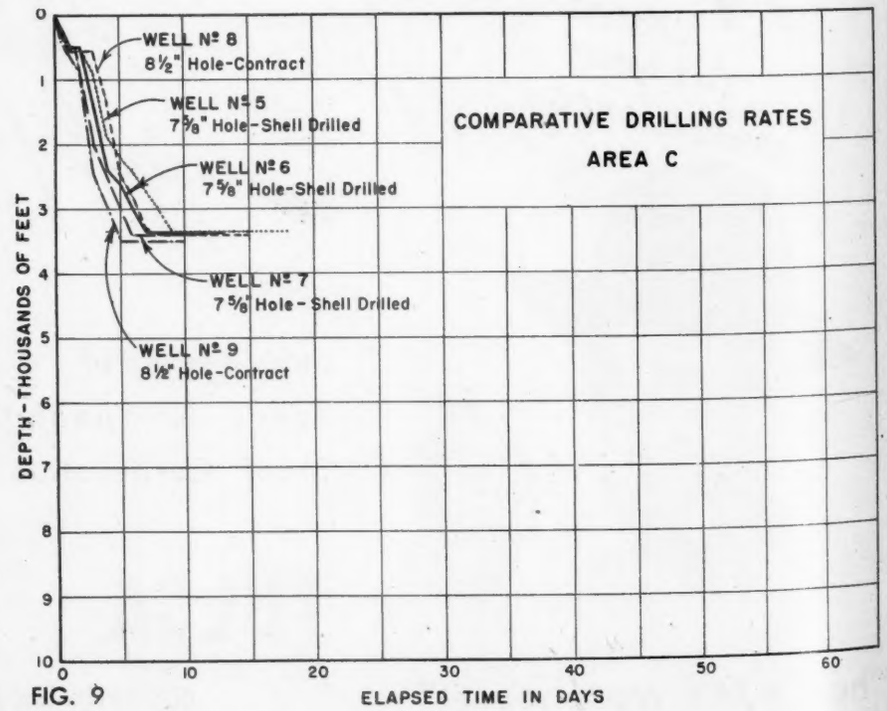

FIG. 9

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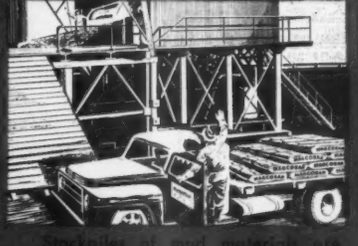

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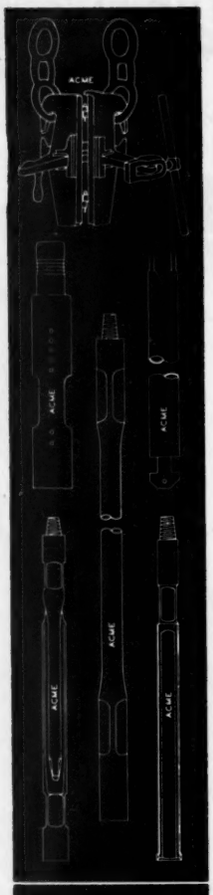

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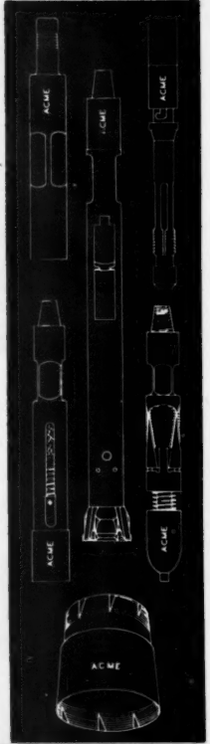

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TABLE 3. Recapitulation of costs of wells drilled in area "E."

Well No.	Hole size (inches)	Cost per foot (dollars)	Adjusted cost (dollars)	No. days abandoning (after reaching deepest depth)	Casing size (inches)	Contract or shell	Completion date	Tubing or drill pipe (inches)
Abandoned wells (no casing)								
18	6¾	5.48	5.65	2	...	S	8-18-47	3½ T.
17	8½	10.68	11.40	7	...	C	7-11-47	4½ D.P.
Abandoned wells with casing								
16	8½	14.09	14.70	12	5½	C	6-9-47	4½ D.P.
Completed wells				No. days completing				
12	8½	20.05	25.10	36	5½	C	2-5-46	4½ D.P.
13	6¾	10.48	12.95	12	4¾	S	10-4-46	3½ T.
14	8½	14.44	15.13	23	5½	C	3-3-47	4½ D.P.
15	8½	12.23	12.80	8	5½	C	4-25-47	4½ D.P.
19	6¾	9.94	9.94	17	4¾	S	10-12-47	3½ T.

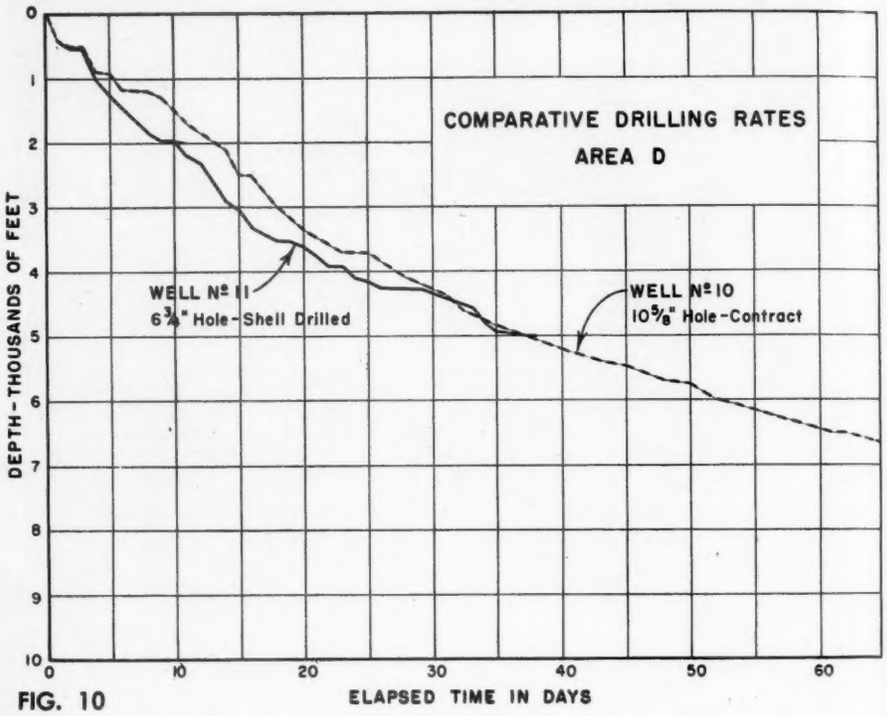

FIG. 10

FIG. 11

cent per foot, making the net cost to the well about $460. In addition, 804 collars were used (including 241 replaced at the completion of the well) at a cost of $2725 to which should be added rig time for changing 563 collars at the rig (2 minutes per collar at 61 cents per minute) or $685. If we assume that the pipe used is 50 per cent depreciated which would amount to ($0.755 — .50 × 10,319 ft) × 50 per cent = $1315, this gives a total cost of $460 + $2725 + $685 + $1315 = $5185 for 202 days operation, or $25.66 per day for depreciation and maintenance of drill tubing. As previously stated, no direct comparisons with drill pipe costs are available but comparing the foregoing to a minimum drill pipe rental figure of $.01 per foot per day leaves little doubt as to the saving possible with drill tubing.

Early studies of lightweight alloy drill tubes, together with the indicated saving through the use of lightweight drilling equipment, led to the belief that exploitation wells could be drilled more economically by employing the same technique of lightweight equipment handling lightweight pipe. Subsequently, 12,000 ft of 4½-in. OD, 9.4-lb, .205-in. wall, 8740 steel Acme-thread upset tubing was purchased.

Since that time, 9 wells have been drilled with this 4½-in. lightweight tubing. These wells, as can be seen from Table 1, ranged in depth from 3650 to 6150 ft and the hole size included 8⅝-, 9⅝- and one 11-in. hole. The footage drilled by these tubes to date totals about 40,000 ft, requiring 246 roundtrips.

Normal California techniques were employed insofar as table speed (50 to 300 rpm) and weight on bottom (4000 to 18,000 lb) were concerned. Also, the normal functions of formation testing, plugging, whipstocking, fishing, and squeeze cementing were performed with these tubes without difficulty.

To date, 32 collars have been changed and 2 joints have been retired. The life remaining in the tubes is not known but physical inspection indicates that at present the tubes show no appreciable wear in the pipe or threads. No twist-offs have occurred, but while drilling one well the pipe became stuck owing to lost circulation and had to be shot off, leaving 4 singles, the drill collars and the bit in the hole, which were later cemented and then sidetracked.

For comparative purposes the eight 4½-in. tubing-drilled wells have been divided into groups. In the first group of 3 (Fig. 12), it is possible to compare drilling progress to a depth of 5135 ft before noncomparable opera-

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TABLE 4. Recapitulation of costs of wells drilled in areas "C" and "D."

	Depth (feet)	Hole size (inches)	Cost per foot (dollars)	Adjusted cost per foot (dollars)	Contract or Shell	Completion date	Tubing or drill pipe (inches)
Area "C"							
Well 5.....	3350	7⅞	13.07	15.24	S	12-29-46	3½ T.
Well 6.....	3350	7⅞	9.03	10.28	S	1-14-47	3½ T.
Well 7.....	3400	7⅞	8.39	9.83	S	1-28-47	3½ T.
Well 8.....	3400	8½	10.41	11.25	C	4-8-47	4½ D.P.
Well 9.....	3500	8½	9.35	9.35	C	2-2-48	4½ D.P.
Area "D"							
Well 10.....	7006	8½	15.84	23.42	C	6-30-44	4½ D.P.
Well 11.....	5000	6¾	10.61	10.61	S	6-13-47	3½ T.

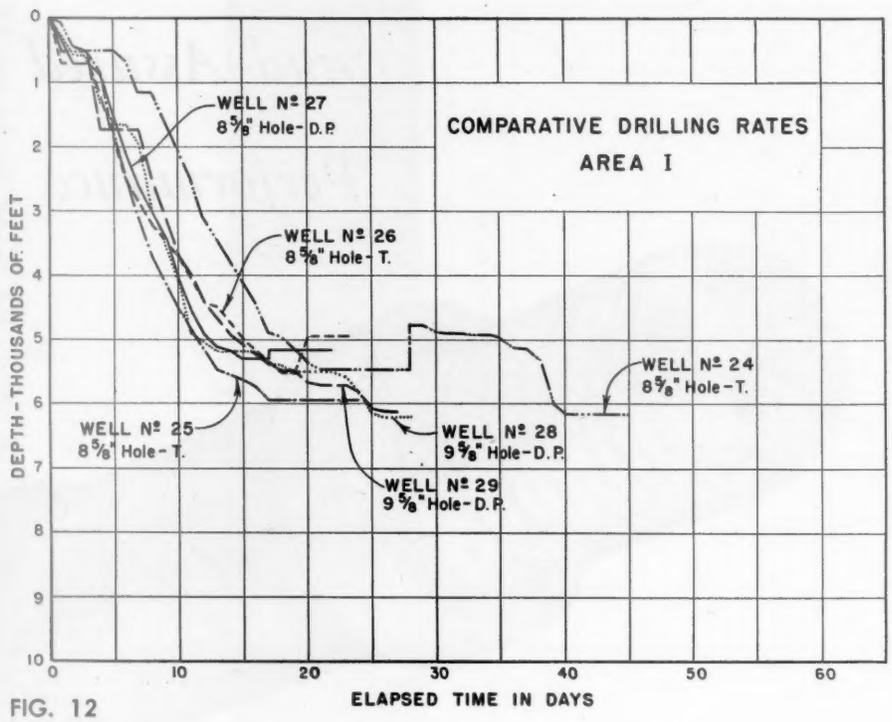

FIG. 12

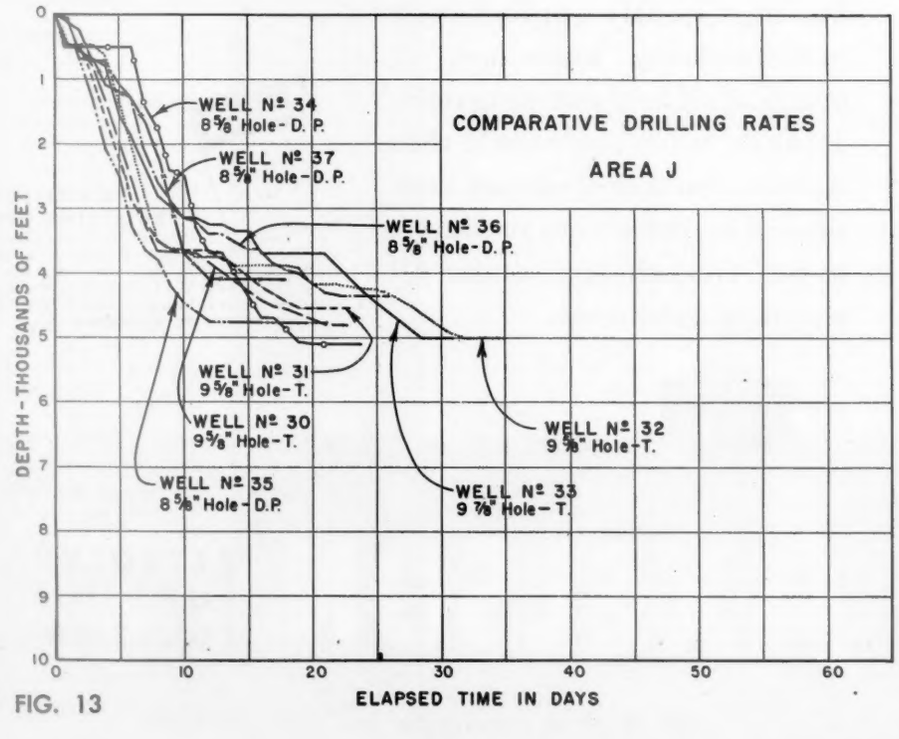

FIG. 13

tions such as drillstem tests or lost circulation occurred. The tubing-drilled wells reached this depth in the average time of 18½ days exclusive of rig-up time, whereas the average time for the conventional rig was 16 days. If the first tubing-drilled hole (19 days), which experienced some mechanical trouble with the hoist, is eliminated, the average for the remaining 2 wells is 14 days; or in other words, the rate of penetration is comparable. The average daily operating cost for the tubing-drilled wells was $1000 per day and the average cost per foot was $10.65, which is comparable to $1152 per day and $12.16 per foot for the conventional rig.

The second group of 4 tubing-drilled wells (Fig. 13) is comparable only to a depth of 3300 ft. The average time for the tubing-drilled wells was 8½ days whereas comparable conventionally drilled wells reached this depth in 9 days. Comparisons at greater depths in this group of wells cannot be made because of severe lost circulation encountered.

Well 38 in Table 1 was a whipstocked well and comparable data are not available.

In judging these comparisons it must be remembered that all wells using 4½-in. tubing as drill pipe were drilled with a small rig having a 96-ft mast and a 270-hp Diesel power plant, whereas all wells drilled with drill pipe employed equipment pulling full 93-ft stands and powered with a minimum of 700 hp.

In addition to the foregoing, we have used 2½-in. 6.5-lb J-55 external upset tubing with Acme-type threads for completion purposes on 10 wells in the Ventura Avenue field ranging in depth from 4500 to 8400 ft. After the 7-in. casing has been cemented at the top of the pay section, the tubing is made up and anywhere from 270 ft to 1050 ft of new 6-, 6⅛- or 6¼-in. hole drilled. The number of round-trips ranged from 4 to 11 per well and included bit changes, shoe and formation testing, plugging, sidewall sampling and liner hanging. Detailed analysis indicates that these operations are performed with tubing as rapidly as with drill pipe. To date, no indications of tubing leaks have been noticed.

In view of our experience to date, which has been highlighted in the foregoing discussion, we are convinced that in many instances drilling costs can be reduced by substituting lightweight tubing with Acme-type threads for heavier drill pipe as this permits the use of a smaller drilling rig with attendant reduction in moving and operating cost without sacrifice of drilling progress. * * *

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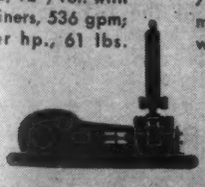
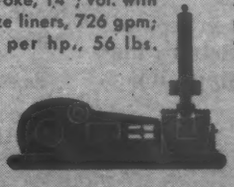
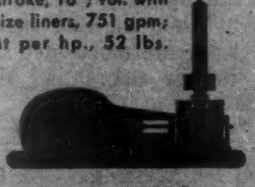


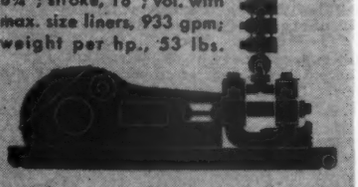
D-300: Hp. input, 300 at 70 rpm; max. size liners, 7½"; stroke, 14"; vol. with max. size liners, 726 gpm; weight per hp., 56 lbs.



D-500: Hp. input, 500 at 65 rpm; max. size liners, 7½"; stroke, 16"; vol. with max. size liners, 751 gpm; weight per hp., 52 lbs.



D-850: Hp. input, 850 at 60 rpm; max. size liners, 8¼"; stroke, 18"; vol. with max. size liners, 933 gpm; weight per hp., 53 lbs.



Water Flooding in the Humboldt-Chanute Oil Field, Neosho and Allen Counties, Kansas

JOHN C. JOERS,[1] PETER GRANDONE,[2] D. B. TALIAFERRO[3]

This is the second article on this subject. The first one, published June 1950, dealt with two projects in the area, the Lynde, Walter and Darby flood and Keas Drilling Company flood.

DEEP ROCK OIL CORP. FLOOD

Although the Deep Rock Oil Corp.'s water flooding project northwest of Chanute, Kansas, in secs. 16, 17, 18, and 19—T26S—R18E, Allen County, includes one of the oldest water-flooding operations in the state, the project has been under the present ownership for only about a year. Water flooding was started by Matson, Towne and Melvin in April, 1938 on 12 acres of the Berry and Burtiss leases in sec. 18 on the western end of the present project (Fig. 5). The project was developed gradually, and at the end of 1946 it covered 104 acres. Fourteen acres on the Stewart and McKinley leases in secs. 16 and 17, near the eastern limits of the present development, were placed under flood in October, 1941 by the Williams Producing Company. The flood was extended to cover 56 acres by 1946 when the project was purchased by Matson, Towne and Melvin. The combined projects were extended to include about 200 acres by November, 1947, when the properties were sold to Sloan and Zook. This new operator developed about 20 additional acres on the west group of leases and 10 on the east leases by July 1, 1948, when the entire project was sold to the Deep Rock Oil Corporation. During 1949, the properties were developed at an accelerated rate, and at the end of the year a total of 304 acres was being flooded.

The formation being flooded consists of two stringers of Bartlesville sandstone, the upper, extending north from the Wadley lease in sec. 19 (Fig. 5) across the Burtiss and Fraker leases, and the lower, (the more extensive) running from the Berry lease in sec. 18 across the entire project to the McKinley and Stewart leases of the former flood of Williams Producing Company in secs. 17 and 16, respectively. The productive sandstone of the north-south stringer (including the Matson, Towne and Melvin development) is at a depth of about 800 ft and has a thickness of 35 to 60 ft; on the east end of the project (Williams Producing Company development) the depth of the productive section is about 810 ft and the thickness averages about 17 ft. A nonproductive upper sand on the east end of the development is separated from the productive stratum by 26 ft of shale.

Average results of the analyses of several Bartlesville sand cores from both ends of the project are as follows:

	West side	East side
Net sand thickness, feet	38	17
Permeability, millidarcys	126	.....
Porosity, per cent	21	19
Oil saturation, per cent	46	35
Water saturation, per cent	32	42
Residual oil saturation (flood-pot), per cent	33	23
Total oil content, barrels per acre	28,770	15,700
Oil recovery (flood-pot), per cent	8,400	4,549
Oil recovery (estimated), per cent	6,950	3,500

Gravity of the oil produced from the west group of leases is 28 to 29 deg API.

Initial development was started on the Burtiss and Wadley leases by drilling four wells during 1914 and 1915, but most of the original drilling occurred during 1919 and 1920. Vacuum was the only stimulative method of production applied to the leases before water flooding, and this method was continued for only 6 months in 1923, because the results were not favorable.

When the initial water-flooding developments were started, the rate of oil production had decreased to 18 bbl per day from 9 wells on the Matson, Towne and Melvin leases and to 6 bbl per day on the Williams Producing Company leases.

When the east and west groups of leases were operated separately by the former operators, Mississippi limestone water was injected without chemical treatment or filtering (closed system) on the Matson, Towne and Melvin properties. A mixture of Neosho River water and returned brine was injected after chemical treatment and filtering on the Williams Producing Company leases. The present operator uses only one plant, employing chemical treatment and filtration. During the first week of April, 1950, the plant was handling about 2150 bbl of water daily. Of this quantity, 450 bbl was produced brine and the remainder was fresh water from the Neosho River.

The present treatment of water varies little from the usual pattern. Water from the river is pumped into an earthen settling pond, where it is mixed with produced water from the oil-tank batteries. The mixed water then flows by gravity through the treating house, where chemicals are added by a mechanical feeder, and through a flume to a second earthen pond for chemical reacting and settling. From the treating pond the water is pumped into a standpipe 37 ft high, made of 16-in. pipe, which is designed to maintain a constant head of water on the filter. This hydrostatic head causes the water to flow through pressure filters into a 500-bbl clear-water tank. Two pressure filters are provided, one filled with sand on rock and the other with a special filtering material† on rock. Only the sand-filled unit is being used continuously. Water from the clear tank is being injected at a plant pressure of 700 psi by means of one triplex pump driven by a 50-hp gas engine.

During April, 1950 the chemical treament for a daily throughput of 2150 bbl of water consisted of 100 lb of alum, 12 lb of ammonium sulfate, 12 lb of copper sulfate, and 10 to 12 lb of HTH (chlorine liberating agent). Both copper sulfate and HTH are algaecides. During this period the pH of the raw river water was 8.2 and the produced brine 7.7. An attempt is made to hold the pH of the treated water at 7.5.

[1]Assistant petroleum engineer, Petroleum and Natural Gas Branch, Bureau of Mines, Petroleum Experiment Station, Bartlesville, Oklahoma.
[2]Petroleum engineer at above station.
[3]Principal petroleum engineer at above station.

†Anthrafilt.

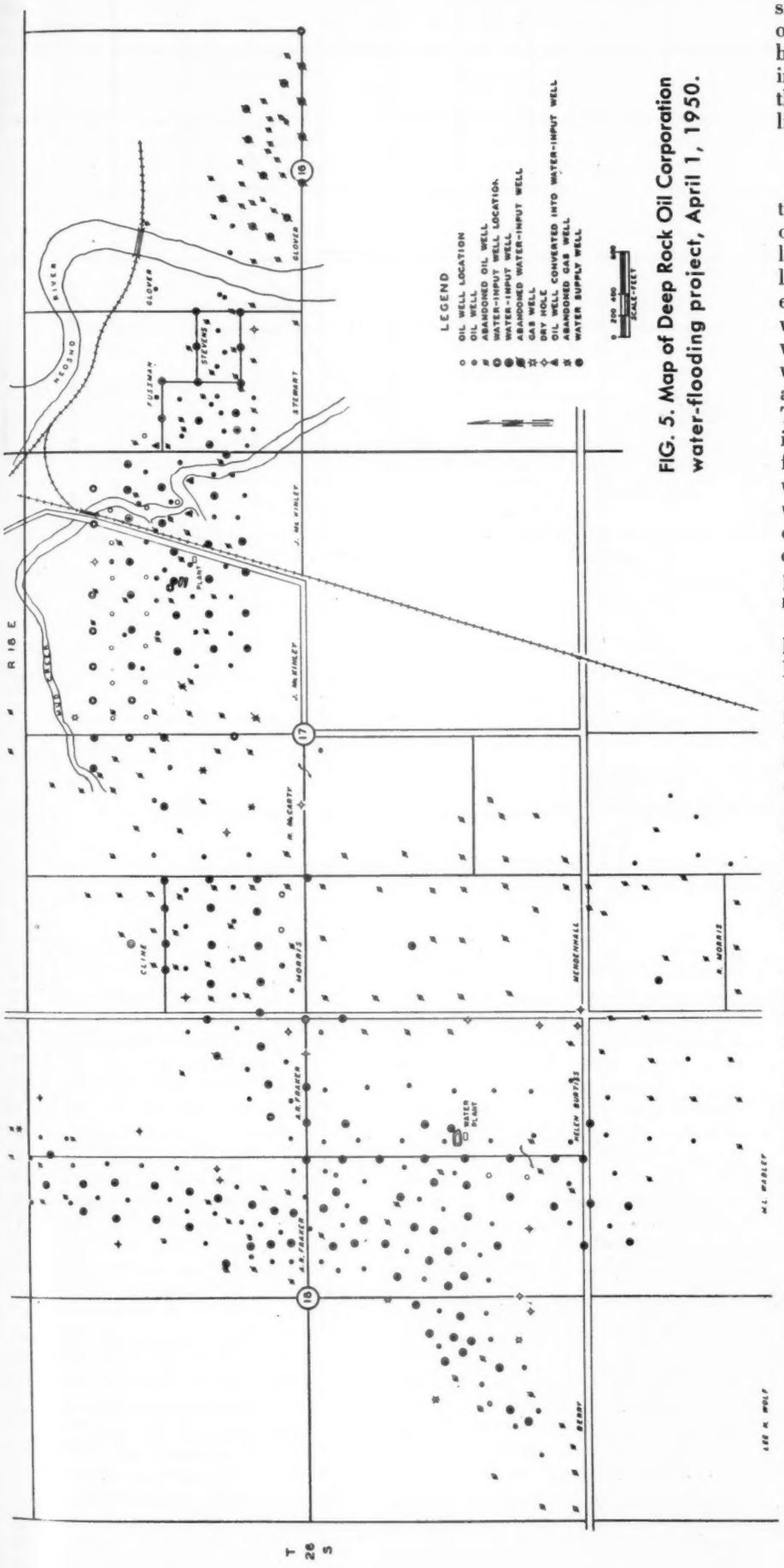


FIG. 5. Map of Deep Rock Oil Corporation water-flooding project, April 1, 1950.

There had been evidence of corrosion of pipe and subsequent clogging of input wells by the treated water, but this condition was remedied by the installation of cement-lined pipe for the water distribution system. Cement-lined tubing also is used in all wells.

Water-Flood Operation

Matson, Towne and Melvin began the original 12-acre flood development on the Fraker, Burtiss, and Berry leases (Fig. 5) early in 1938, drilling like wells about 200 ft apart. However, there was no regular pattern of wells, because many of the existing oil wells were included in the project. All wells were drilled through the sand and shot with liquid nitroglycerin. Two quarts per foot of sand were used in the producing wells and 1½ qt per foot in the injection wells. As the wells were completed for pumping, they were cased with about 750 ft of 6½- or 6⅝-in. casing; input wells were equipped with 1½-in. tubing set on a packer on top of the sand and cemented.

The Williams Producing Company began water flooding the Stewart and McKinley leases during October, 1941. They also used an irregular flooding pattern, because existing oil wells were used. Producing wells were cased with 630 ft of 6¼- or 4⅞-in. casing to accommodate the 2-in. pumping string; input wells were equipped with 2-in. tubing set on a packer at the top of the sand (810 ft) and cemented. All wells on these leases were shot with 1½ qt of nitroglycerin per foot of sand.

The present operator has converted the entire project from a pumping to a flowing operation except for a few wells. All new wells, therefore, whether for injection or production, are completed alike. The wells are shot selectively with 2½ to 4½ qt of nitroglycerin per ft of sand, starting at a depth 5 ft below the packer point. They are equipped with 2-in. cement-lined tubing set on a packer at the top of the sand and cemented. During drilling operations the wells are cased to the top of the sand, but the casing is pulled after installing the 2-in. tubing. One to three joints of 6¼-in. surface pipe are left mudded in place. The drilling of producing wells is delayed until the sand is filled by the injection of water into surrounding input wells. This makes it necessary to reduce the formation pressure temporarily while drilling in new producing wells by shutting in local input wells.

All development by the present operator is on a 5-spot pattern with like wells spaced 330 ft apart. No old wells now are being used, except a few that happened to be located properly in

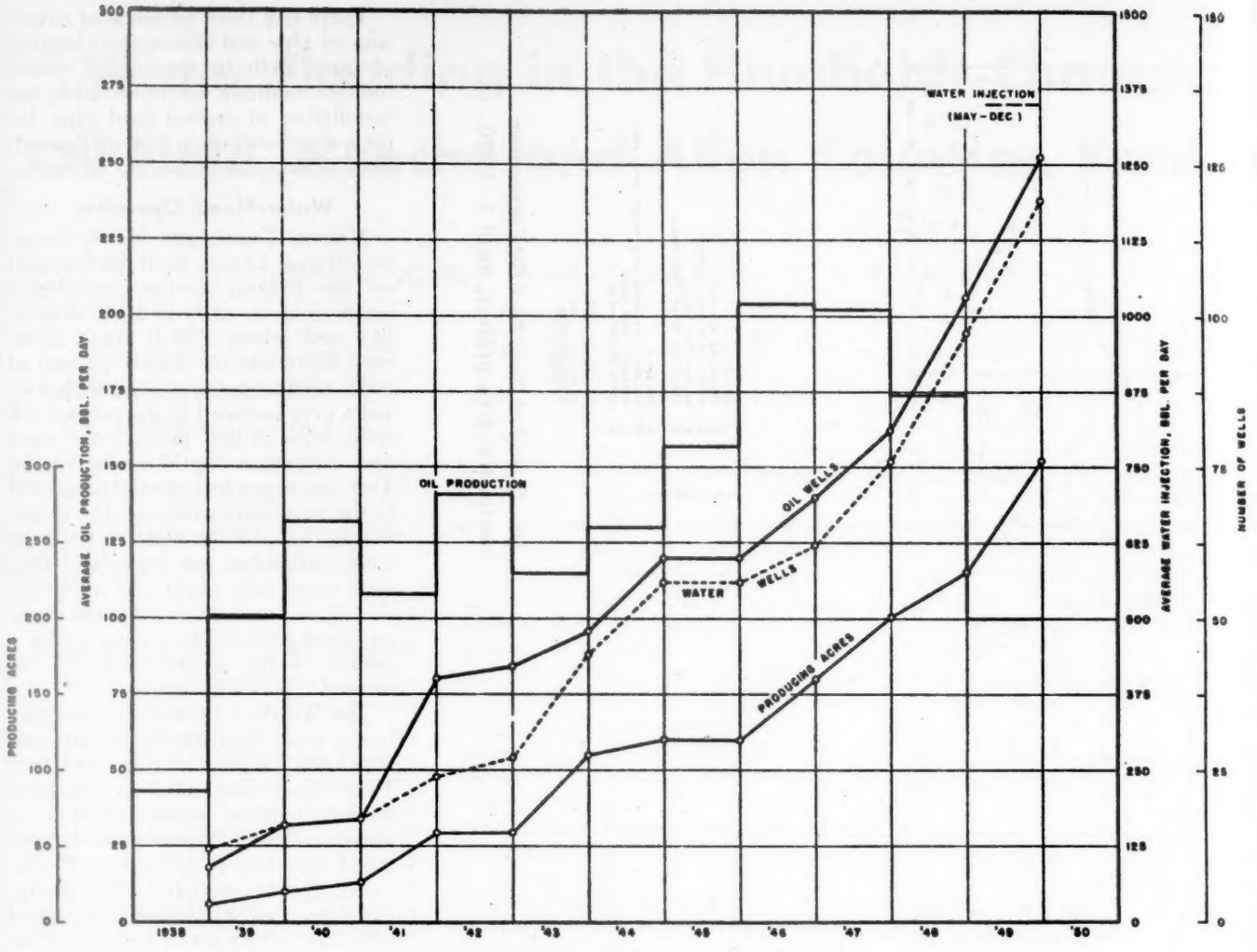


FIG. 6. Production history of Deep Rock Oil Corporation water-flooding project.

the pattern for producing wells. At the end of 1949, there were 304 acres under flood on which there were 119 input wells and 126 oil wells. Of the producing wells, 19 were being pumped and 107 were flowing.

The Deep Rock Oil Corporation injects water into each well at a daily rate of 2.5 bbl per foot of sand (about 1 bbl per acre-foot), but frequently the maintenance of this rate depends on the availability of an adequate quantity of water. The fill-up time has been 3 to 6 months at this injection rate. All input wells are equipped with meters, which are read daily for proper control of injected water, whereas the rate of water production is measured weekly at the water separators on the leases. The rate of oil and water production from individual wells is measured periodically with a 55-gal test tank. When input wells show indications of increasing back-pressure, the sand face is washed with water by means of an air-lift tube run through the 2-in. tubing. In more extreme cases the sand face is washed with hydrochloric acid through a separate wash tube. The acid is allowed to stand over night in the well and then the excess either is dispersed into the formation with water pressure or is displaced from the well through the same wash string. Use of the wash string prevents contact of the acid with the cement lining. Acid treatment of input wells on the Morris lease (40 acres) has increased the water-input rate of these wells 35 per cent, and there is evidence of an increase in oil production. A similar treatment of wells on the McKinley lease was completed too recently for evaluation of results.

Results of Flooding

Production records show that to the end of 1947 the first two operators had recovered 486,500 bbl of oil from about 200 acres under flood, or 2432 bbl per acre. By the end of 1949, the entire project had produced 586,560 bbl of oil from a total development of 304 acres, or an average recovery of about 1930 bbl of oil per acre. The decrease in recovery on a per acre basis is attributable to the large percentage of the flood that has been developed so recently that it has not had time to reach its peak of production much less give any reliable indication of the ultimate recovery to be obtained. The two original projects, covering about 200 acres on 5 leases, had produced nearly 2850 bbl of oil per acre by the end of 1949. After 11 years of operation, the Burtiss lease still is producing about 32 per cent as much oil as it did in the year (1942) of peak flood production. On the other hand, at the end of 11 years the Berry lease was producing only about 3.5 per cent as much as it did during its peak production year (1940).

Fig. 6 shows graphically the average daily rate of oil production each year. The rate of development of the project is reflected by curves showing the areal extent of the flood and the number of injection and producing wells in use. The average oil-producing rate during 1949 was 100 bbl per day, although the rate at the end of the year was 125 bbl per day. The year of peak production was 1946 when the average rate was 204 bbl of oil daily. Only

incomplete records of the rate and amount of water injected by the former operators are available. An average of 1370 bbl of water per day was injected during the last 8 months of 1949, but at the end of the year 1687 bbl of water per day were being injected into 119 input wells. At the end of 1949, 13.5 bbl of water were being injected per barrel of oil produced. Six barrels of water were being produced with each barrel of oil. The difference in the injected water:oil produced ratio and the produced water:oil ratio give an indication of the amount of water being utilized to fill up the voids in the sand body.

COX AND HAMON FLOOD

Cox and Hamon began water injection on a pilot project in sec. 16—T26S—R18E, in Allen County, Kansas about a mile south of Humboldt, near the middle of January, 1950. Although the present development covers only about 20 acres, it is on a unitized block of about 500 acres, which inincludes parts of secs. 15, 16, 21, and 22—T26S—R18E. The entire block will be developed after experience has been acquired from the pilot project. Production is from the Bartlesville sand, which occurs in this area at a depth of 875 ft. The oil produced has a gravity of 34 deg API. No information is available on the history of the property prior to flooding.

Brine from one supply well drilled into the Mississippi limestone at a depth of 1200 ft is used for flooding. This well is completed with 7-in. casing, and water is pumped from it through 2½-in. plastic-lined tubing directly to the input wells by a small, submerged centrifugal pump.[8] Return water separated at the tank battery is admitted into the casinghead of the supply well, where it mixes with the Mississippi-lime water before being pumped into the injection system. As the closed-type system is used, no chemical treatment or filtering is applied to the raw water. During April, 1950, the submerged pump was delivering about 200 bbl of water per day at a line pressure of 600 psi—the capacity of the pump at this pressure. No additional pumping equipment therefore is needed on the surface for water injection.

The pilot project includes four new oil wells and four new water-injection wells. These are located so as to permit a 5-spot development with a spacing of 880 ft between like wells, but their arrangement does not provide a complete 5-spot pattern. Three old oil wells in the vicinity of the new development are pumped by a central power.

[8]Reda.

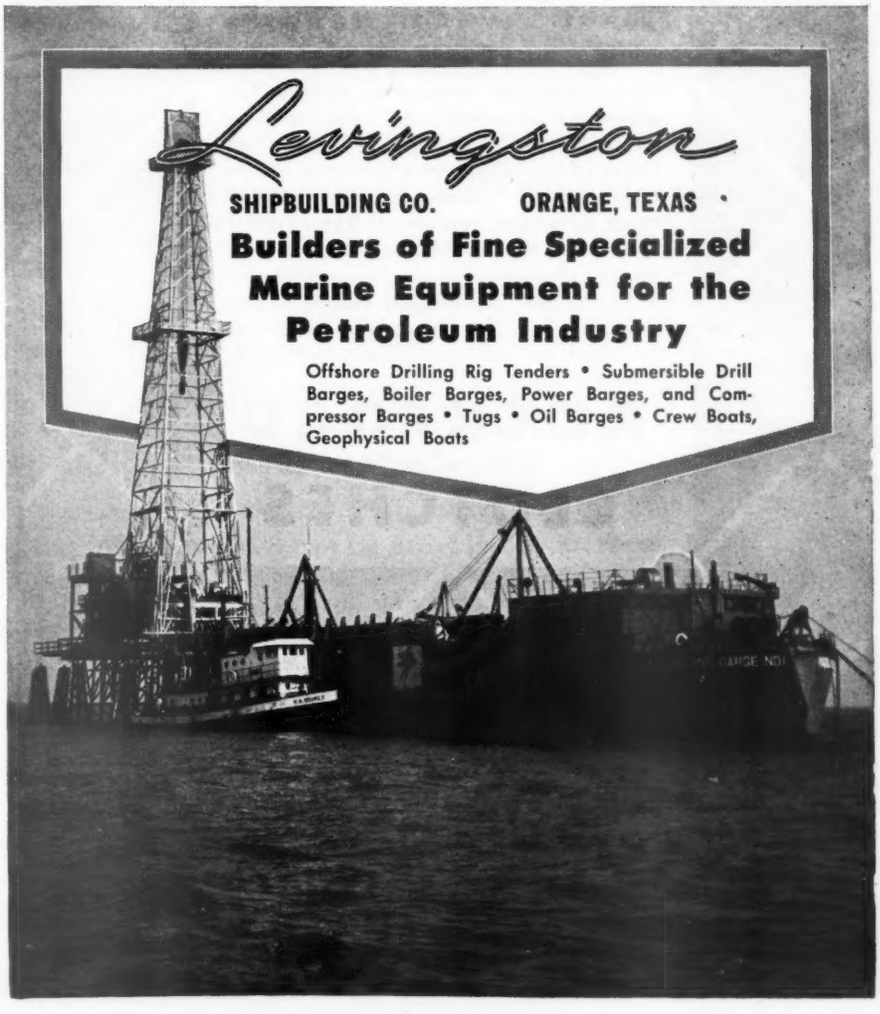
The well-completion practice has been to drill through the sand, complete the wells without shooting, and case only the producing wells, using 5½-in. casing, which is cemented at the top of the sand. One joint of 8-in. surface pipe is used in each producing well. Input wells are equipped with 2½-in. plastic-lined tubing cemented at the top of the sand.

The project is of particular interest because of the novel use of hydraulic pumping equipment[9] in the producing wells. This equipment, which is designed for much deeper production, is being used for the first time to pump shallow (875-ft) production. Also, it is the first installation on a waterflooding project. Pumping is entirely automatic and can be continued indefinitely, even if the wells are under water; unless a mechanical failure or an interruption in the electric power supply occurs.

The hydraulic pump is a reciprocating, double-acting type that rests in the lower end of the 2-in. tubing near the bottom of the well and is actuated by oil that is forced down from the surface. The oil that drives the pump is forced down the 2-in. tubing by a triplex pump, which is placed centrally on the lease. As the "power" oil discharges from the power cylinder of the Kobe pump, it enters the intake side of the pump with the formation oil, and the mixture is pumped to the surface through a 1-in. string of tubing lying alongside the 2-in. tubing in the well. The pump may readily be raised to the top of the tubing for inspection, merely by reversing the circulation of the "power" oil. The triplex pump driving the "power" oil has adequate capacity to provide power to pump a total of 480 bbl of liquid daily from the producing wells. This capacity may be divided between any number of wells. During warm weather the wells are pumped during alternate 4-hr periods, but during cold weather they are pumped continuously to prevent freezing of lines leading to the tank battery. Intermittent pumping is controlled automatically by electric time clocks. The fluid level in the wells is kept low at all times. Produced oil from the wells passes to a header, which is equipped to permit production measurement on individual wells with a meter.‡ From the header the oil passes through a heat treater, thence into a high 200-bbl settling tank through a "boot," in which the water and oil are separated. Oil from the settling tank flows into

[9]Kobe.

‡Bowser.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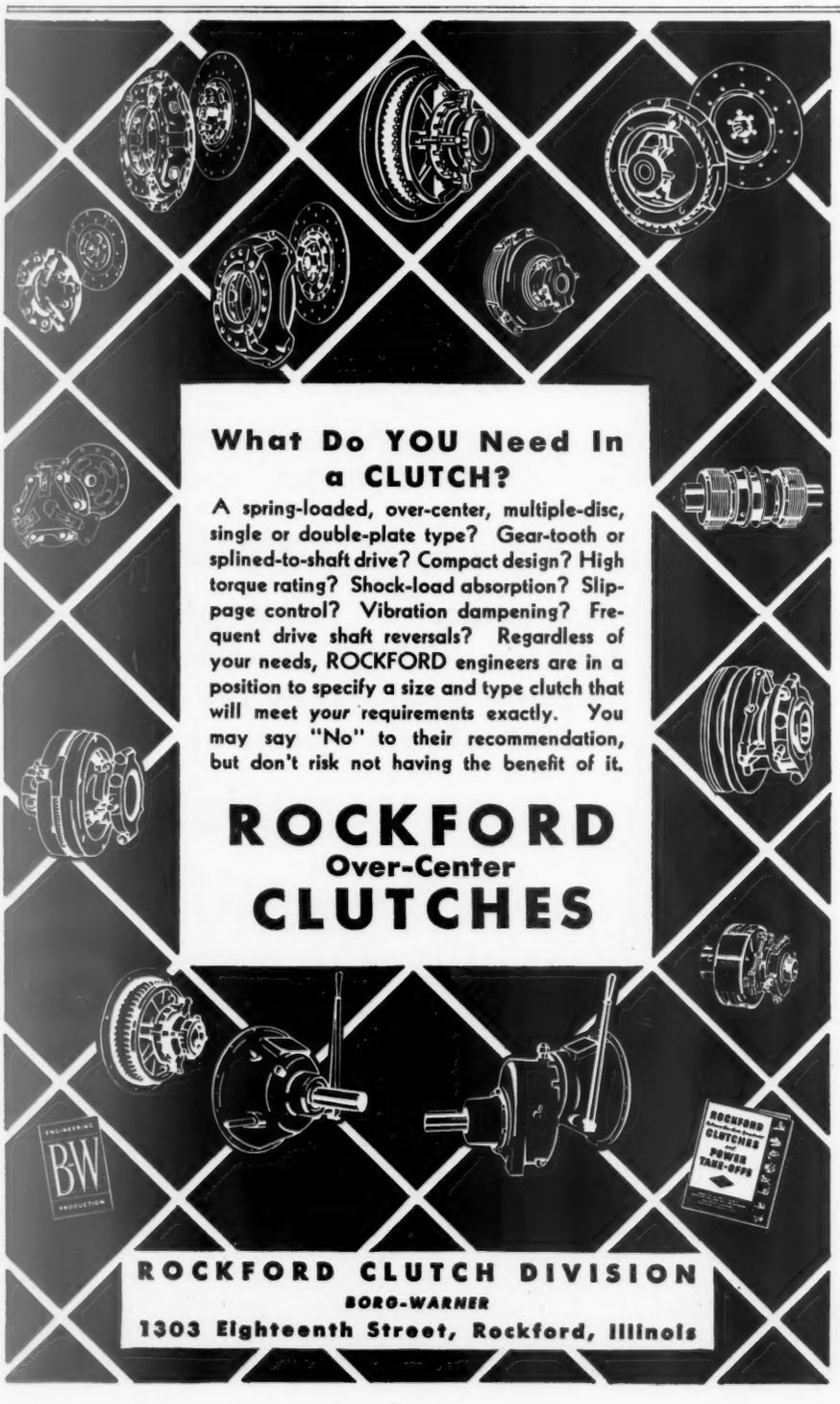
two low 250-bbl tanks for storage. A 500-bbl tank is connected to the settling tank and "floats" in the system to provide storage for "power" oil to operate the hydraulic pumps in the individual wells. Water from the treater and the settling tank passes into a low 250-bbl tank, from which it flows through a meter into the casinghead of the water-supply well. A small centrifugal pump installed at the tank battery is connected so that tank bottoms may be pumped from any of the tanks back into the treater.

Water-injection wells are equipped individually with meters. The input rate in each of the four wells during April, 1950 was about 50 bbl of water per day, but the operator intends to increase this slightly by installing a larger pumping unit in the supply well. It is estimated that 8 months will be required to fill the sand at the present rate of water injection.

All lines on the pilot operation are laid on the surface of the ground without protection from the weather to determine if the expense of burying lines can be avoided. Experience last winter with the surface lines was that no freezing occurred at temperatures down to 10 F and that by increasing the flow of "power" oil no freezing occured down to 0 F.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Results of Flooding

The 20-acre pilot flood of Cox and Hamon is an experimental operation in many respects, and it has not been in operation long enough to obtain significant results on the experimental features or on the oil recovery that may be obtained. The novel use of hydraulic pumps in the producing wells will make it possible to operate the project continuously regardless of high water from the Neosho River, which sometimes covers parts of the leases in the unitized tract. The hydraulic means of lifting the pump to the surface for repair will eliminate the cost of rod- and tubing-pulling jobs, which are necessary to repair conventional pumping equipment.

The maintenance of low liquid levels in the oil wells during the early life of the project is an especially desirable feature for the operator. Through this initial installation of hydraulic pumping equipment the operator will determine (1) the feasibility of using this equipment economically in shallow wells, (2) the ability of the equipment to pump salt water, (3) the ability of the equipment to operate when the wellheads are under water, (4) flexibility of the units over a wide range of rates during the life of the flood, (5) ability of the equipment to maintain low liquid levels in the producing wells, and (6) the extent to which tubing-pulling jobs will be eliminated.

The existing wells were producing 3 bbl of oil daily before the new wells were drilled. In April, 1950, the daily rate of production was 13 bbl of oil and 20 bbl of water.

Acknowledgment

The work on this report was done under the general supervision of R. A. Cattell, chief, Petroleum and Natural Gas Branch, Bureau of Mines, Washington, D. C., and H. C. Fowler, superintendent, Petroleum Experiment Station, Bureau of Mines, Bartlesville, Oklahoma.

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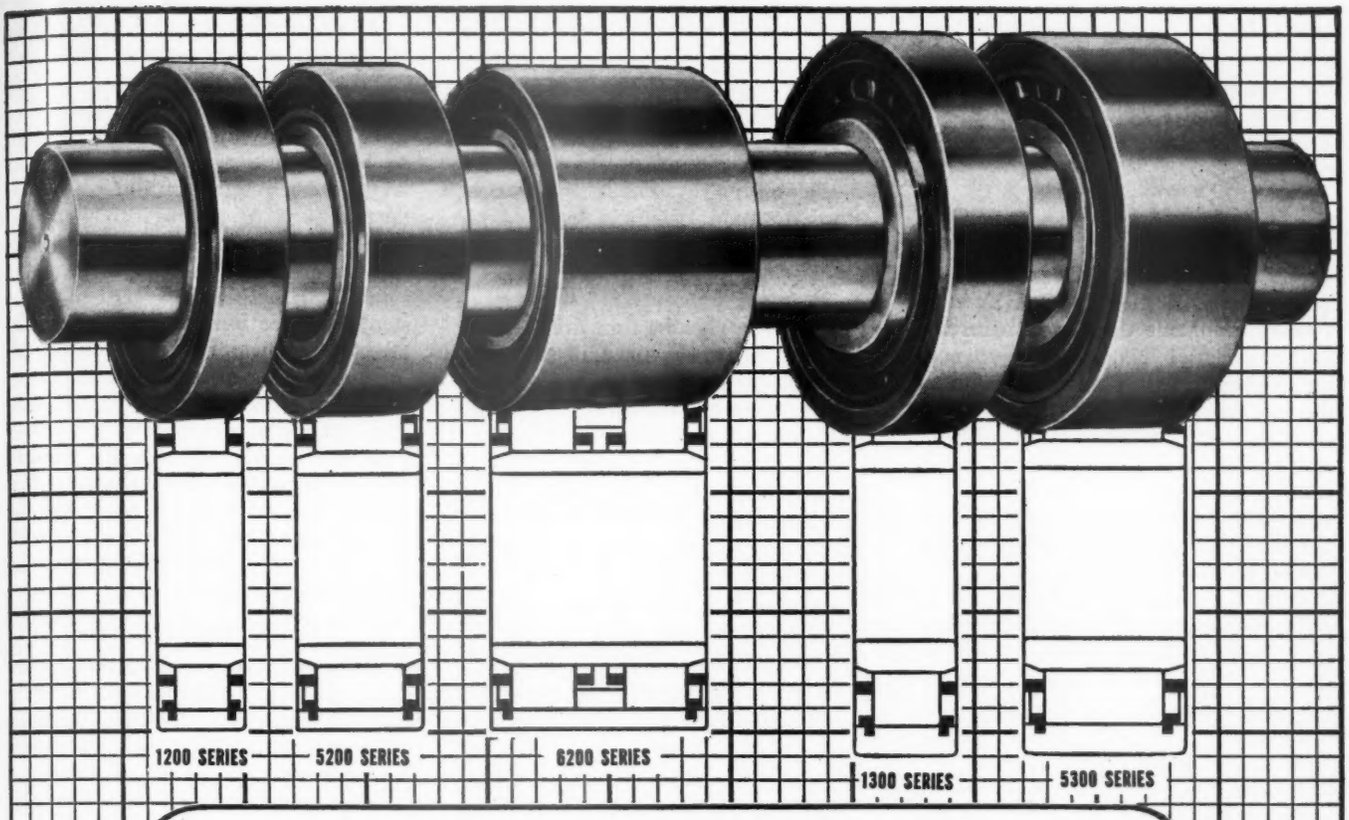
* * *



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SELECTING THE DRILL STEM‡

BRUNO SCHABARUM* AND STANLEY MOORE†

MORE emphasis than ever before is being placed by contractors on economical operation. This is indicated by the fact that greater care is being taken in matching the capacity of drilling rigs to the work to be done as it has been recognized that over loading equipment results in slower rates of penetration and in excessively high maintenance costs.

It is the purpose of this paper to point out the field in which further study and work can be done so as to decrease the loads on present drilling equipment or increase its depth capacity.

It would appear that a basic relation exists between the horse-power available on the rig, drill stem size, and the depth and diameter of hole to be drilled. Such other factors as mud characteristics, bit designs, stand lengths, etc., while important, are not considered as basic.

The principal purposes of the surface equipment are: One, to hoist the drill stem out of the hole whenever it is necessary to replace the bit; and two, to maintain a proper rate of circulation of the drilling fluid through the drill stem, bit and annulus. The first problem is strictly a mechanical one, while the second is one in hydraulics. The mechanical function of rotating the pipe is not considered for the reason that power requirements are generally small and little can be done to reduce this requirement by changing drill stem size.

Hoisting Requirements

In West Texas the rig horsepower requirements set forth by the operating companies for 10,000-ft drilling is not less than 1000 hp. It is predicated on using 4½-in. drill pipe and boring 8¾-in. hole to 10,000 ft. This gives a figure of one horsepower for each 10 ft of depth.

This factor seems to work out quite well even for more shallow wells. For example, at Scurry County, the North Snyder pool which is approximately 6750 ft deep would call for rigs with a rating of 675 hp. It so happens that most of the rigs in this area are of this size. With 4½ in. drill stem and 60,000 lb of drill collars, the average trip to 6500 ft with a rig of 675 hp takes about 3.8 hr.

With the same rig and 3½ in. pipe and 40,000 lb of drill collars, the time on an average trip is 2.9 hr, which results in a saving of nearly one hour per trip.

Another factor to consider is that the small bits generally used with 3½ in. pipe do not last as long under comparable load conditions as the larger 8¾ in. bits.

Under the above conditions at Scurry County, the 12¼-8¾ in. hole pattern requires an average of 41 bits, while the 11-6¾ in. requires 51 bits. From this it can be seen that there is a saving of 7.9 hr in hoisting time per well when the slim hole pattern is used. This is slightly more than 1 per cent of the time on the well.

Another illustration we might use is that of 10,000-11,000-ft work. In Ector County, West Texas area, we have drilled wells in which we have followed the 13⅜-9⅝ in. and 7 in. casing pattern, while other off-set wells have been drilled with the 10¾-7⅝ in. and 5½ in. casing pattern. The same rig and same crews were used. The rig was one having a rating of 1000 hp behind the drawworks.

Large hole pattern.

Well	Trips	Trip hours	Hr/trip
A	144	597½	....
B	121	491¼	....
C	139	533¾	....
Average	135	541	4.01

Slim hole pattern.

Well	Trips	Trip hours	Hr/trip
D	166	671¾	....
E	173	650¾	....
Average	169	661¼	3.92

It is noteworthy that the average trip with small pipe only took six minutes less than with the larger 4½ in. drill pipe.

The above illustrations show that there is not much savings in time in hoisting when using little pipe over the larger drill stem, provided of course that the rig has adequate power to do the job in the first place. It also clearly shows that a change in drill stem specification will not materially affect the power required for the efficient hoisting of the drill stem.

In view of the above, and the fact that at least 65 per cent of the power generated on the rig is finally used to impart energy to the drilling fluid, it would seem advisable to look into the hydraulics of the drill stem and well bore as a possible means of reducing the load on the rig.

The Hydraulics Factor

In the past not enough attention has been given to hydraulic efficiency in making drill stem selections. As wells become deeper, this factor becomes increasingly important, because a greater percentage of the available pumping capacity is expended overcoming losses down the drill stem bore and up the well bore annulus. In fact, the benefits to be gained even in moderately deep holes are far greater than commonly realized.

We find that thinking is even now influenced by Oklahoma City and Seminole experiences, where 6⅝ in. drill pipe was used to make 11-in. holes to about 3800 ft. Losses attributable to the drill stem amounted to only about 75 psi, or 15 per cent of the total, whereas the loss through the single water course in the Simplex bit may have been 4 or 5 times this amount. Therefore, at that time the most important hydraulics factor was the nozzle in the bit.

Today, losses attributable to the drill stem, including drill collars, usually amount to 80 or 90 per cent of the total pump pressure. In a sense the majority of this loss is wasted energy and it appears that efforts should be made to increase efficiency here. All indications are that these losses can be cut in half on the average operation, and the total energy required to operate a rotary rig reduced by 30 to 40 per cent.

If the comparatively new technique known as "jet drilling" is to be effectively utilized, attention must be given to the hydraulic efficiency of the circulating system. This method calls for the expending of considerable energy at the bit nozzles to obtain high jetting velocities. If large quantities of energy are uselessly wasted circulating through a poorly designed circulating system, it becomes a problem indeed

‡Presented at the ninth annual meeting of American Association of Oilwell Drilling Contractors, at the Baker Hotel, Dallas, Texas, September 19-21, 1949.

*Carl B. King Drilling Company, Midland, Texas.
†Drill Collar Service Company, Midland, Texas.

to provide enough power to produce the high velocity jets desired at the bit.

No doubt, the slowness of improvement in the hydraulics of drill stem is largely due to a general lack of attention to the importance of relatively small differences in the internal diameters of tubular members which conduct the flow. Let us give you one example that we think demonstrates more clearly than any other, the importance of design for hydraulic efficiency:

In selecting drill collars, how much thought do you give to the difference between 2 and 2¼-in. bore? It is only ¼ in., but if you are a West Texas operator, running 20 drill collars and circulating 250 gpm, it means 15 to 25 per cent difference in the efficiency of your entire pumping operation. Think of the significance of this in terms of equipment, maintenance, and fuel costs.

To appreciate the importance of internal diameters, consider the fact that it takes about 32 times as much power to circulate through a 1 in. ID pipe as through a 2 in. ID pipe. In terms of drill stem this means:

a. Twice as much power is required to circulate through a 2 in. bore drill collar as through a 2¼ in. bore drill collar.

b. Twelve times as much power is required to circulate through a 2 in. bore drill collar as through a 3 in. bore drill collar.

c. Two and one-half times as much power is required to circulate through 3½ in. OD drill pipe as through 4 in. OD drill pipe.

d. Five times as much power is required to circulate through 3½ in. OD drill pipe as through 4½ in. OD drill pipe.

e. Eight times as much power is required to circulate through 3½ in. OD drill pipe as through 5 in. OD drill pipe.

Generally, larger diameter drill stem than that in use today is desirable for improvement of hydraulic efficiency. Aside from the hoisting problem, which has already been discussed, there are several other operational factors to be considered when recommending larger size drill pipe. A number of these are discussed separately below:

Elevator Shoulders

On the average, the tool joints in use today are 1¼ in. to 1½ in. larger in diameter than the drill pipe. With present methods of attaching tool joints to drill pipe, this great difference in diameter is not needed for strength in the connection between tool joint and drill pipe. The only apparent reasons remaining for having the tool joints so much larger than the drill pipe are to provide an elevator shoulder and to make allowances for abravise wear on the outside diameter. This large elevator shoulder constitutes a real obstruction to hydraulic efficiency, especially in the smaller size holes.

In view of the fact that the most efficient drill stem has tool joints that are only about ¾ in. larger in diameter than the drill pipe, it would seem advisable to make some arrangement that would permit lifting it without the use of elevator plugs. In fact, we see no reason why such tool joints should not be made with the 18 deg taper elevator shoulder, reinforced with tungsten carbide hard facing, and used in the conventional manner.

Fishing Space

The tendency to use small drill stem to permit abundant space for fishing usually results in poor hydraulic efficiency. Developments in fishing tools and fishing methods have reduced the space required. Consideration of the benefits to be attained from a hydraulics standpoint should be enough to cause us to take advantage of these developments. Metallurgical and de-

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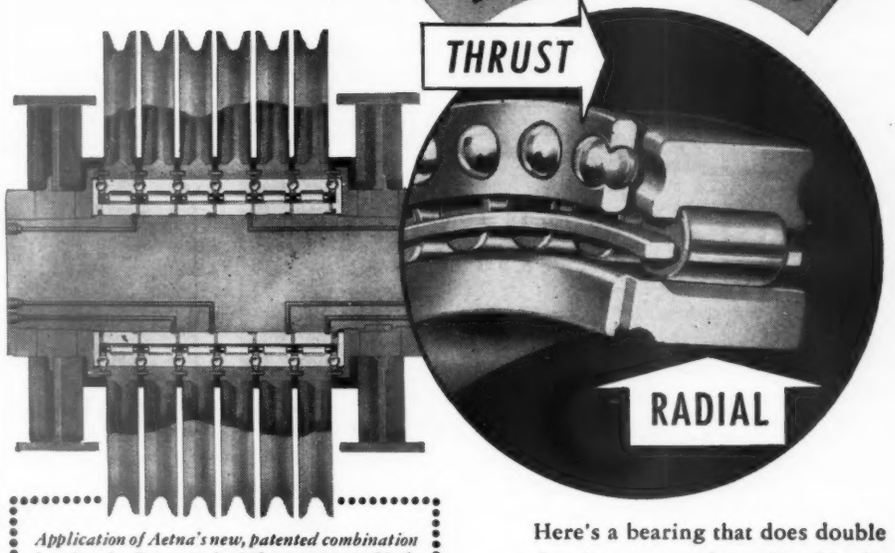

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sign improvements have made possible the building of strong fishing tools that require very little space. Overshots, for example, can be obtained that will catch 5½ in. OD tool joints in 6¾ in. hole—and 7 in. OD tool joints in 8¾ in. hole.

It would be well to point out here the relation between fishing space and elevator shoulders. If wide elevator shoulders are not required, then fishing space will be no problem. For example, 4½ in. OD drill pipe is the most efficient size for use in 6¾ in. hole. The most efficient tool joints would be the 4½ in. slim hole or double streamline types, which have an OD of only 5 in. and these would not be an obstruction to fishing. Should we demand that a regular elevator shoulder be used, then the pipe would have to be smaller or the tool joint larger. Smaller pipe would restrict the flow. Larger tool joints would not only reduce the fishing space, but they would also reduce hydraulic efficiency by restricting the flow in the annulus.

Effect on Bottom Hole Pressure

A little known or considered factor in the selection of drill stem is its effect on bottom hole pressures. When circulation is started, the bottom hole pressure increases by the amount of pressure required to force the drilling fluid up the annulus between the drill stem and well bore. When the drill stem is withdrawn from the hole, the bottom hole pressure decreases because the drill stem itself acts as a swab. In either case, the effects are greater if drill pipe, tool joints, or drill collars are made larger in outside diameter.

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Oil activities in the Gulf Coast tidelands have to date produced about $1 for every $10 invested. It costs much more to find and produce oil from steel platforms perched out in the Gulf of Mexico than in on-shore drilling.

Let us consider the bottom hole pressure increase in an 8¾ in. hole at 10,000 ft, circulating 450 gal per min. Remembering that many assumptions must be made to arrive at any figures at all, we calculate the increase, when using 4½ in. full hole drill stem and 20—6¼ in. OD drill collars, at 149 psi. If the drill stem size is increased to 5 in. extra hole, the pressure increase during circulation would be about 190 psi. If the drill stem size were further increased to 5½ in. double streamline, pressure increase during circulation would be about 230 psi.

No doubt, some will be interested in the effect of drill collars having an OD slightly smaller than the bit size. Let us consider 8 in. OD drill collars in 8¾ in. hole, using 450 gal per min. The pressure increase on bottom for each drill collar added would be somewhere near 45 psi. If the circulation rate were 350 gal per min, the increase per drill collar would be approximately 27 psi. If 7 in. OD drill collars were used in the 8¾ in. hole, the increase would be about 4 psi per collar added for 450 gal per min and about 3 psi per collar added for 350 gal per min.

Return Velocity

For specific rates of circulation, the return velocity will be increased when drill stem size is increased. This is desirable from several standpoints.

In order to study the possibilities for improvement over present typical practices, we have prepared the 4 tables at the back of this paper. We have considered moderate rates of circulation at moderate depths, and higher rates at greater depths. Note that the examples shown for 6500 ft drilling fit the conditions in Scurry County, Texas, which promises to be the most active area for several years.

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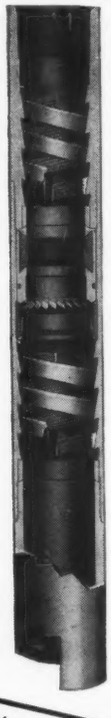

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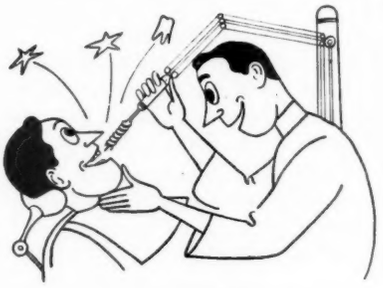

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TABLE 1. Approximate pressure losses in 6¾-in. hole at 6500 ft, circulating 200 gpm.

Description of drill stem	Part of system	Loss, psi	Fluid hp
3½ inch Internal flush—5 inch OD tool joints—20 - 5½ inch OD by 2 inch ID by 30 foot drill collars.	Drill pipe bore and annulus	540	61
	Drill collar bore and annulus	360	42
	Bit—with three 5/8-in. jets	60	7
	Surface connections	20	2
	Total pump pressure	980	112
4 inch Full hole—5¼ inch OD tool joints—20 - 5½ inch OD by 2¼ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	360	42
	Drill collar bore and annulus	230	27
	Bit—with three 5/8-in. jets	60	7
	Surface connections	20	2
	Total pump pressure	670	77
4½ inch Slim hole—5 inch OD tool joints—20 - 5½ inch OD by 2½ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	290	34
	Drill collar bore and annulus	135	16
	Bit—with 3—5/8 inch jets	60	7
	Surface connections	20	2
	Total pump pressure	505	59

TABLE 2. Approximate pressure losses in 8¾-in. hole at 6500 ft, circulating 350 gpm.

Description of drill stem	Part of system	Loss, psi	Fluid hp
4½ inch Full hole—5¾ inch OD tool joints—20 - 6 inch OD by 2¼ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	380	78
	Drill collars and annulus	430	87
	Bit—with three 11/16-in. jets	140	28
	Surface connections	65	13
	Total pump pressure	1015	206
5 inch Extra hole—6¼ inch OD tool joints—20 - 6¼ inch OD by 2¾ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	200	41
	Drill collar bore and annulus	165	33
	Bit—with three 11/16-in. jets	140	28
	Surface connections	65	13
	Total pump pressure	570	115

TABLE 3. Approximate pressure losses in 6¾-in. hole at 10,000 ft, circulating 250 gpm.

Description of drill stem	Part of system	Loss, psi	Fluid hp
3½ inch Internal flush 5 inch OD tool joints—20 - 5½ inch OD by 2 inch ID by 30 foot drill collars.	Drill pipe bore and annulus	1300	190
	Drill collar bore and annulus	480	70
	Bit—with three 5/8-in. jets	90	13
	Surface connections	30	4
	Total pump pressure	1900	277
4 inch Full hole—5¼ inch OD tool joints—20 - 5½ inch OD by 2¼ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	900	131
	Drill collar bore and annulus	280	41
	Bit—with three5/8-in. jets	90	13
	Surface conncetions	30	4
	Total pump pressure	1300	189
4½ inch Slim hole—5 inch OD tool joints—20 - 5½ inch OD by 2½ inch ID drill collars.	Drill pipe bore and annulus	700	102
	Drill collar bore and annulus	210	31
	Bit—with three 5/8-in. jets	90	13
	Surface connections	30	4
	Total pump pressure	1030	150

TABLE 4. Approximate pressure losses in 8¾-in. hole at 10,000 ft, circulating 450 gpm.

Description of drill stem	Part of system	Loss, psi	Fluid hp
4½ inch Full hole—5¾ inch OD tool joints—20 - 6 inch OD by 2¼ inch ID by 30 foot drill collars.	Drill pipe bore and annulus	1040	271
	Drill collar bore and annulus	640	168
	Bit—with three 5/8-in. jets	220	58
	Surface connections	95	25
	Total pump pressure	1995	522
5 inch Extra hole—6¼ inch OD tool joints—20 - 6¼ inch OD by 2¾ inch ID drill collars.	Drill pipe bore and annulus	600	158
	Drill collar bore and annulus	250	66
	Bit—with three 5/8-in. jets	220	58
	Surface connections	95	25
	Total pump pressure	1165	307
5½ inch Double streamline—6¼ inch OD tool joints —20 - 6¼ inch OD by 3 inch ID drill collars.	Drill pipe bore and annulus	470	123
	Drill collar bore and annulus	185	48
	Bit—with three 5/8-in jets	220	58
	Surface connections	95	25
	Total pump pressure	970	254

Note from Tables 1 and 2 above that very appreciable improvements can be made even at moderate depths and at moderate circulation rates. Power requirements can be cut in half for both 6¾ in. and 8¾ in. holes. The bore of drill collars is important in either case.

The examples shown in Tables 3 and 4 indicate that higher rates of circulation, using long strings of drill collars, are very difficult to attain if the presently popular designs are used. Desired objectives are easily attainable, however, if proper attention is given to hydraulic efficiency.

We have already discussed many of the objections usually raised to the use of larger drill stem. In the case of larger bore drill collars, two objections are usually raised. It is pointed out that larger bore weakens the pin and reduces the weight of the collar.

As regards the strength of the pin member on larger bore drill collars, it is true that the pin will be weakened if the bore is greater on the same size pin. If, however, the desired bores and outside diameters are selected

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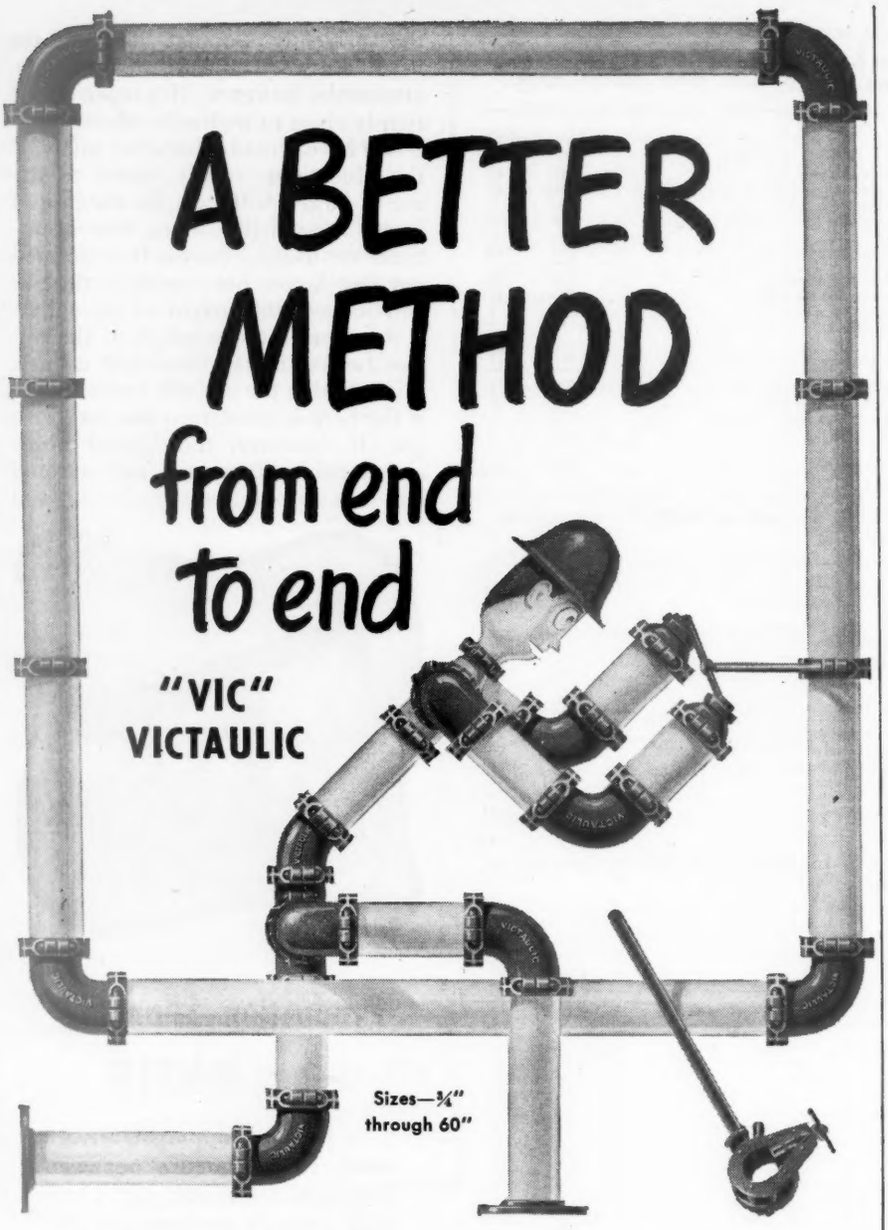

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first, and the connection size then selected for maximum strength, the resulting drill collar will be as strong in resisting fatigue as one with smaller bore. Further, advancements in the design and metallurgical processing of drill collar connections has increased their strength to such a point that the bore can be safely increased in many instances on a particular size connection without any sacrifice.

The losses in weight, due to increasing the bore, are small compared to the benefits obtained. If the bore of a 30-ft drill collar is increased from 2 in. to 2¼ in., the weight loss is 82 lb. If the bore of a 30-ft drill collar is increased from 2¼ in. to 2¾ in., the weight loss is 200 lb. A study of the differences in pressure losses in drill collars shown in Tables 1 through 4 indicates that the larger bore drill collars are best from an operational standpoint, even though it may be necessary to use one or 2 more drill collars to attain the weight desired.

Conclusions

1. If the depth rating of the rig is established by using a multiplying factor of 10 times the horsepower rating then adequate power will be available to hoist any size drill stem with no appreciable difference in efficiency.
2. Considerable improvement over present drill stem specifications are indicated by better selection of size, based on the hydraulic characteristics of the drill pipe, tool joints, and drill collars as related to well bore sizes.
3. The improvements in hydraulic efficiency that can be attained are of such magnitude that rig operating costs can be materially reduced.
4. Available information on hydraulics is largely based on theory and potential benefits appear to be important enough to merit field study by Association members, with the objective of establishing drill stem standards to more nearly fit the hole patterns now being drilled.

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* * *

This is the Lee C. Moore 136-ft cantilever mast that drilled to 13,563 ft, deepest reached by a portable mast.

Deepest Well for Portable Mast Drilled in California

THE deepest well ever drilled with a portable mast is Shell Oil Company's Shell-Lloyd A-3 in the Ventura Avenue field in Southern California. The project was drilled under contract by Rocky Mountain Drilling Company, and was completed at 13,563 ft in 127 days elapsed time. The outfit employed on the job was a National 125 featuring a Lee C Moore, 136-ft cantilever mast—the whole designed and constructed to drill to 15,000 ft. The unit performed with no trouble whatever, although one or two operational problems developed that gave Shell engineers as well as the contractors a few uncomfortable moments.

Mud circulation was lost in the early stages but was quickly restored, and little occurred to mar a near perfect record until at 11,347 ft a drill collar sub parted, and it was necessary to fish for the bit and 3 drill collars. Fortunately the fish was picked up on the first run, and the crew was making hole again in very quick time. So far the luck was good, but coming out of the hole at the 12,670 mark the pipe was caught in a keystone, and there was occasion for real worry because in this field such an eventuality is usually responsible for long protracted delay. By dint of good workmanship and the exercise of caution, however, that danger was passed, and operations were continued in about 2½ days time. Casing, 7-in. OD, 38 lb and 36 lb, at 12,676 ft, was run to bottom in 10½ hr; the drill pipe was changed from 4½-in., 16.60 lb, to 3½-in., 15.50 lb; and the hole was then carried down to 13,563 ft without further interruption.

EXCLUSIVE

It might be noted that 12,000 ft of 4½-in. drill pipe was standing at one time on one side of the racking platform before it became necessary to switch to the other side, and just before the 7-in. casing was run, a total of 12,678 ft was racked on the two sides.

Again, near the close of operations, there was stacked on one side 14,000 ft of 2½-in. tubing, while on the other side was 13,500 ft of 3½-in. drill pipe. In all respects, indeed, the mast stood up well.

It has a spread at bottom of 21 ft laterally and a back leg spread of from 18 ft 9 in. to approximately 20 ft 9 in. The top equivalents are 5 ft 10 in. and 4 ft 6 in. There is plenty of clearance, permitting the use of the largest and heaviest crown blocks. The one actually employed on this mast was a 60-in. manganese fast sheave and five 42-in. manganese sheaves, grooved for 1¼-in. line; mounted on heat-treated shafts, and equipped with roller bearings.

The racking platform has a total capacity of 15,660 ft of 4½-in. drill pipe, and is so designed that racking can be done on either side of the working platform. The main section holds 9720 ft and the auxiliary section, which can be covered over when not in use, is good for 5940 ft. Incidentally, the height of the racking platform is adjustable so that it can be accommodated to various lengths of drill pipe stand.

The entire mast and all its component parts were engineered to yield the ideal balance between strength, general utility, and heavy duty performance. Safety and facility of operation have also been prime factors in design, and the successful completion of Shell-Lloyd A-3 at 13,563 ft, besides being a record for portable mast operation, is a pretty convincing demonstration that, in capable hands, portable masts can be adapted to deep drilling with a minimum of trouble. The shut-downs on this job were certainly of minor import, and minor though they were, they could not by any process of reasoning be ascribed to the mast itself, or, indeed, any part of it. * * *

NEWS

Sheldon Speaks To AIME Junior Chapter

The junior section of the Pacific Petroleum Chapter of the American Institute of Mining and Metallurgical Engineers met recently at the Rio Hondo Club, Downey, California to discuss subsurface instruments in reservoir engineering.

Main speaker was W. C. Sheldon, reservoir engineer for the Ohio Oil Company, who emphasized the many problems confronting the reservoir engineer. In his analysis, the engineer must rely upon well data, which are often based on relatively few and poor sample points. Also, the data must be interpreted to properly develop intrinsic reservoir properties. Such factors as completion effectiveness and producing conditions imposed will cloud the picture. Sheldon coined the term "well effectiveness", the ratio of what the well is doing to what it should do, to describe the major clouding factors in producing well analysis.

Once these factors are properly isolated, those factors that make up intrinsic reservoir properties are equally difficult to evaluate. Reservoir size, zone thickness, lithologic properties, depth and pressure, composition, saturation, permeability and its distribution, should all be considered in a proper analysis.

Saudi Arabia Production

Crude oil production in Saudi Arabia during June amounted to 16,879,210 bbl or an average of 562,640 bbl per calendar day, it was announced by the Arabian American Oil Company. This made a total of 88,529,593 bbl of crude oil produced for the first 6 months of 1950, an average of 489,114 bbl per calendar day. Production in May totaled 17,078,238 bbl or 550,911 per calendar day.

Italians Drill for Steam

A drilling process very similar to that employed in drilling for oil has been used to drill to volcanic steam for the generation of electricity in a remote section of Tuscany, Italy, 40 miles south of Florence. The steam appears to result from the seepage of water down through semi-porous rock layers to deep lying beds of hot lava, collecting in crevices and caverns in the subsurface.

Grant Oil Tool Company has supplied for use in the drilling process a series of large size reamers with cutters, varying in weight from 1840 to 3900 lb, and measuring in overall length 9 to 11 ft. Diameters range from 16⅛ in. to 23 in.

Sunray, Barnsdall Merge

Exploration, drilling, and production operations of Sunray Oil Corporation and Barnsdall Oil Company in California are being consolidated, as a result of the recent merger between the two companies following approval of the merger by a large majority of stockholders of both corporations.

The California Division will be referred to as the Barnsdall Division of Sunray Oil Company, and is under the direction of W. C. Whaley, recently elected vice president and director of Sunray Oil. Personnel of the merged organizations will remain largely the same. California headquarters are in the former Barnsdall Oil Company offices in the Petroleum Building, Los Angeles.

Combined production operations in California include 387 productive wells in 15 fields in the state, with a total production of about 22,000 bbl of oil per day.

New York Nomads Hold Annual June Golf Party

A golf party was held by the New York Chapter of Nomads at the Ardsley Country Club, Ardsley-on-Hudson, New York in June, at which 98 golfers, hackers, and sundry other types participated in the grand American game of golf. Appropriate prizes were awarded to various guests and members. High-lighting these were:

Low gross—Harold Busold, guest, 77; John D. Evans, member, 86.

Low net—A. Moore, guest, 72; T. N. Shults, member, 74.

Least number of putts—E. W. Berlin, guest, 31; E. R. Smoley, member, 26. Nearest to pin—W. H. Farrand, guest, 10 ft 8 in.; H. S. Purnell, member, 6 ft 8 in.

Longest drive—J. E. Anderson, guest, 262 yards; J. D. Evans, member, 246 yards.

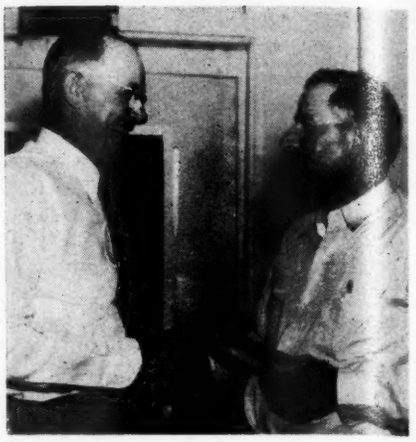
High gross—Frank Curnen, guest, 135; N. L. Boulden, member, 152.

In addition to the above prizes many others were awarded to golfers as well as non-golfers and in particular Tommy Shults was awarded the I. Frank Brown Trophy for members.

Iran Output Up

The Anglo-Iranian Oil Company, Ltd. has reported May's production of crude oil in Iran amounted to 2,771,000 long tons. Production totaled 2,688,000 long tons in April.

The company also reported that total production for the period January 1 to May 31, of this year was 13,053,000 long tons. During the year 1949, Iran produced 26,806,564 long tons of crude oil and the United Kingdom produced 45,419 long tons.



R. E. Sterns (left), superintendent, Humble Oil and Refining Company, New London, congratulates James H. Nelson, roustabout foreman for the Humble, as Nelson receives the 1000th certificate of completion in the University of Texas course, Treating Oil Field Emulsions. This course is sponsored by the American Petroleum Institute, Division of Production.

Drilling Record Set

A new drilling record has been set by German operators in that country. In March, 38,000 m (about 125,000 ft) were drilled in deeper wells. The increase over the February figure is nearly 14,000 m, which is mostly represented by production or field wells. The new record is due partly to the fact that the companies are now using more modern rigs and equipment with which drilling time can be cut and erection and removal accomplished more rapidly.

YPF's Credit Good

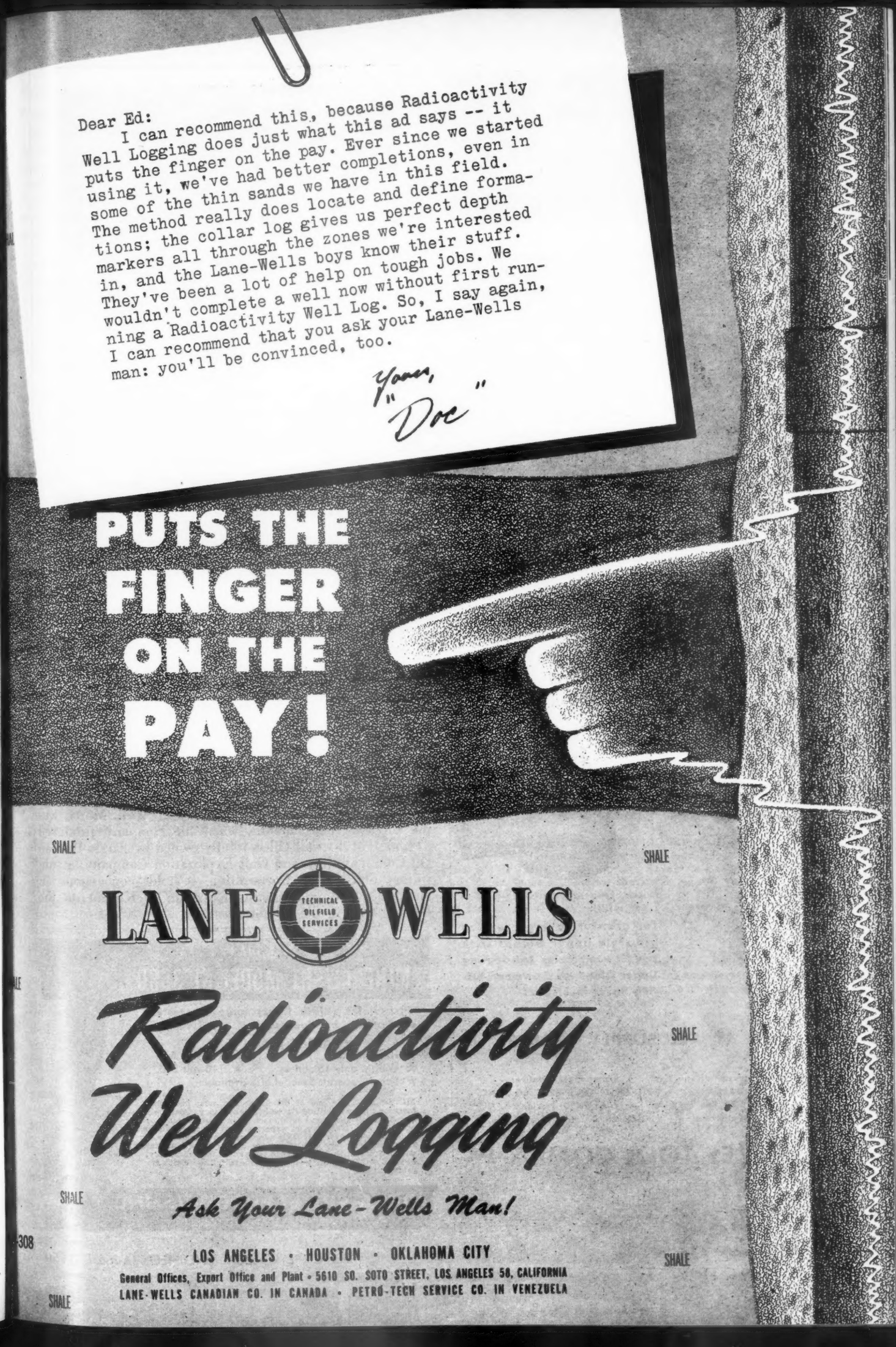
Yacimientos Petroliferos Fiscales of Argentina recently purchased about $500,000 worth of geophysical equipment from Western Geophysical Company. Payment was made promptly under terms of the agreement. Apparently questions about YPF's credit standing are being answered by actual transactions.

Meeting Date Changed

The State Oil and Gas Board, Jackson, Mississippi has changed its regular meeting date from the third Thursday to the third Wednesday of the month, James McClure, chairman, reports.

Elect New Officers

At a recent meeting of the Illinois Geological Society the following new officers were elected: C. W. Donnelly, president; T. E. Wall, vice president; Theo G. Glass, secretary-treasurer.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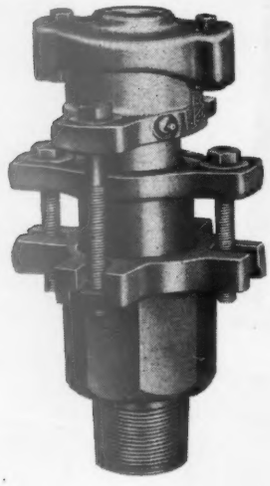

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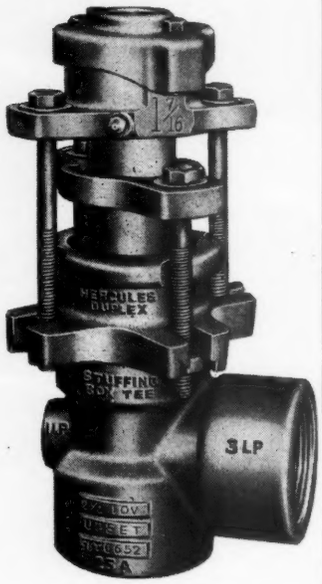

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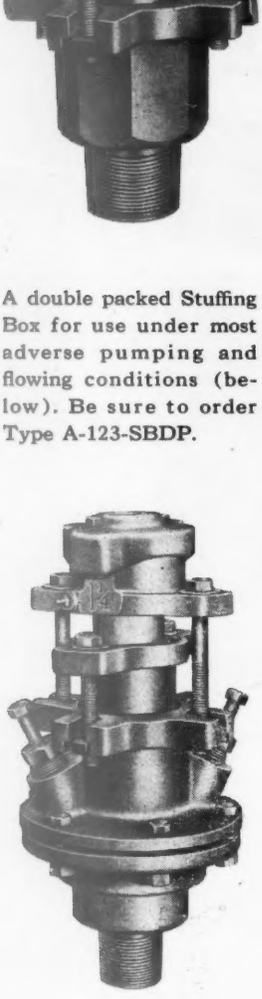

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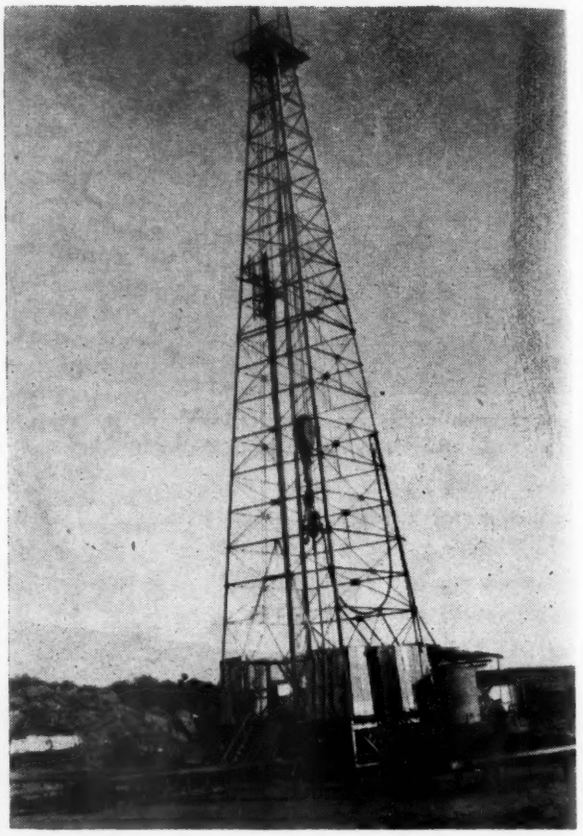

The deep test Federal Land No. 1 is being drilled for Thomas W. Doswell et al by Makin Drilling Company in the San Juan Basin, Rio Arriba County, New Mexico. Gas was encountered in large quantities in Upper Mesa Verde at 5443 but drilling is going ahead to test Dakota formation at about 7800 ft.

Kuwait Output Hits Peak in May

Kuwait Oil Company, Ltd. reached peak crude oil production levels in May. Production averaged about 341,463 bbl daily, up from 305,500 bbl daily in April. March was the previous peak month, when the company produced 311,500 bbl. Kuwait Oil is jointly owned by Anglo-Iranian Oil Company, Ltd. and Gulf Exploration Company, a subsidiary of Gulf Oil Corporation. It holds concessions on about 6000 sq miles in the Kingdom of Kuwait on the Persian Gulf in the Middle East.

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Phillips Divides Producing Areas

Phillips Petroleum Company has divided its active areas of the United States into 4 divisions with a division geologist and landman situated in Bartlesville, Oklahoma in charge of each division. Canada is handled as a separate division.

O. H. Whitcomb is division landman and J. H. Turner, is division geologist of the Northwest area, which consists of Washington, Oregon, Western New Mexico, North Dakota, South Dakota, and the northwest corner of Nebraska.

The southwest division is made up of north-central Texas, West Texas, eastern New Mexico, Texas, and Oklahoma Panhandles and southwest corner of Kansas. H. C. Charles, is the division landman and G. L. Knight has been transferred to Bartlesville from Amarillo as division geologist.

H. H. Charles is division geologist and J. S. Williams is division landman of the northeast division, Oklahoma, Kansas, Nebraska, northwestern Arkansas, Missouri, Iowa, Illinois, Indiana, Kentucky, and Tennessee.

The southeast division includes all of the Gulf Coast, East Texas, South and East Arkansas, Louisiana, Mississippi, Alabama, Florida, Georgia, South and North Carolina. J. E. Kendall, transferred from Houston, will be division landman with R. E. McPhial as division geologist.

H. L. Baldwin is division landman and division geologist for the Canadian division.

Venezuelan Production

The Asiatic Petroleum Corporation produced 448,877 bbl of crude oil in Venezuela during the 5 weeks ending July 3.

Drill in German Tidelands

Germany is getting its first tidelands drilling. Three companies are participating in the well that is being drilled off Cuxhaven on the North Sea at the mouth of the Elbe River.

Preussag, Deutsche Erdoel, and Deutsche Vacuum are interested in the well, with Deutsche Erdoel doing the actual drilling. The rig has been erected on a steel platform about 1½ miles from the shore at Oxstedt-Spieka, southwest of Cuxhaven.

Motor launches, barges, and rafts from a landing stage at the mouth of a small river supply the materials for the drilling. Although the drilling platform soon will have radio, it is connected with the shore by telephone at present. Work can be carried on regardless of the tide, as the derrick is high enough above the sea bottom.

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WHAT'S DOING IN DRILLING

Deep Rock, Gulf Extend Noble Pool

The Ceres extension area in Noble County has been enlarged by 2 producers that may indicate a branching out of the narrow "buried river" trend on the northeast side of the slender pool. Second and third offsets are being added to a recent discovery between the South Ceres and Northeast Longview fields, added by Gulf Oil Company and Deep Rock Oil at separate operations.

Gulf's No. 1 Jirous-State was tested for 116 bbl of load oil and 28 bbl of new crude in 5 hr. It then flowed 102 bbl in 6½ hr with a good volume of gas.

Deep Rock's No. 1 Adriance, south offset to the Gulf well, has been drilled to a total depth of 4436 ft. It flowed 60 bbl of oil the first hour and 25 bbl the second hour, after being opened, following Hydrafrac treatment between 4376-84 ft. Total depth was 4436 ft. It was shut in after 2 hr for tankage.

Two New Wells Are Added To Ventura Avenue Field

The Lloyd Corporation has added another well to the Ventura Avenue field with its No. S-1. The well came in for an initial flow of more than 500 bbl of 32 gravity oil a day. Total depth is 13,450 ft, with casing cemented at 11,997.

Tide Water Associated's new Lloyd No. 160 in the Ventura field is flowing 381 bbl of 30.9 gravity oil and 1,189,000 cu ft of gas a day.

Kentucky Drilled 460 Oil Producers in 1949

Total oil produced in Kentucky during last year amounted to 8,806,230 bbl, 118,061 bbl less than was produced in 1948 according to a report by the American Institute of Mining and Metallurgical Engineers. One-thousand one-hundred and fifteen wells were drilled, 460 of which were oil producers and 459 dry holes.

In Western Kentucky, a 28,000-bbl decrease was noted during the year, but new discoveries and development in Union County during September, which increased production by the end of December to over 100,000 bbl monthly, indicate that 1950 will be a more productive year. Eastern Kentucky's total increased 43,919 bbl due to a 30,000-bbl increase in the new Wolfe County extensions of the old Big Sinking oil fields and to repressuring the Weir sand oil fields of Johnson, Lawrence, and Magoffin counties.

Two deep Knox tests were drilled during last year. Ashland Oil and Refining Company's well in Johnson County was drilled to a total depth of 6110 ft. Gas shows were encountered at 5097 ft to 5100 ft and oil shows from 5365 to 5370 ft. Both oil and water were encountered at 5684 ft, and the well was plugged, pulled, and abandoned.

The second test, drilled by Arch Carpenter, was in Carter County and went to a depth of 3840 ft, but was also abandoned.

The most important gas development was in the Big Sandy gas field. During the year, 186 wells were drilled, 149 of which were gas producers developing a total open flow of 101,950 Mcf. No new gas fields were discovered.

The only new oil development of importance in Eastern Kentucky during the past 5 years, was in the new White Creek field of Wolfe and Powell counties. This development was more of an extension of the Big Sinking field. The 27 new wells drilled there this year brought Wolfe County's annual oil production from a total of 19,000 bbl in 1948 to 50,000 bbl in 1949. Production in Powell County rose from 62,000 bbl in 1948 to 66,000 in 1949.

Wyoming Field Extended

Continental Oil Company's ELCU B-18 in Niobrara County, Wyoming flowed 149 bbl per day of 42 gravity oil from Dakota sand. The well, which is one-half mile south of production in the Niobrara County field, was drilled to a total depth of 3985 ft. Dakota was topped at 3926 ft and second Dakota at 3962 ft. This extension is reportedly separate from Little Buck Creek field proper, on a new high.

Rotary Rigs Operating in Oil Fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Okla. Kansas	Arkansas Louisiana Texas	Illinois	Rocky Mountain Canada	New Mexico West Texas
First	2329	522	131	448	152	153	193	730
Second	2297	521	133	419	144	140	197	743
Third	2256	504	140	411	153	130	185	733
Fourth	2311	518	140	391	155	160	192	755

Bring In Good Producer In Los Angeles Basin

Richfield Oil Company has completed another good producing well in California's East Los Angeles field. It is the U. P. Unit No. 9, which is putting out 1047 net bbl of 34.8 gravity oil from a bottom of 7978 ft.

The company now has 15 producers in the 200-acre field. Approximately 1,563,000 bbl have been produced since the field was opened up in February 1946.

New Hope Pool Widened

Anderson-Prichard Oil Company has perforated at its No. 1 Moore in the New Hope extension area, and is showing gas and distillate from a 2-ft section.

Bottomed at 7100 ft, first holes were made in casing at 6971-73 ft, with the well flowing gas in 30 min and distillate in 3 hr. It made 10 bbl of 55 gravity crude in 24 hr with an estimated 1,000,000 cu ft of gas.

Illinois Well Completed

The Illinois Mid-Continent Company No. 1 Leighty-Klinger, two miles southeast of Lawrenceville in Lawrence County, Illinois, has been completed for 400 bbl of oil a day. The well is flowing from the McClosky limestone at 1814 to 1827 ft. Total depth is 1828 ft. The well has not yet been acidized and is reported to be one of the best in the area to date.

Drill Kentucky Producers

In Henderson County, Kentucky, about five miles northeast of Spottsville oil wells are being completed in the Waltersburg sand. Drilled to a total depth of about 1180 ft, these wells make about 100 bbl of oil a day when completed after being shot. Operators developing this new oil field are Kingwood Oil Company, George Hoffman, and H. C. Farmer.

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H.C. Smith OIL TOOL CO.

GENERAL OFFICES, EXPORT OFFICE AND PLANT COMPTON, CALIFORNIA

PIONEER OF LONG-TOOTH BITS FOR TOP HOLE DIGGING

Missouri Oil Production Shows Increase in 1949

Oil production rose slightly during 1949 in Missouri, though the year's activities were not marked by any notable discovery. Total amount produced was 32,027 bbl, and natural gas sold was 23,340 Mcf, American Institute of Mining and Metallurgical Engineers reported. As nearly as it is possible to determine, 99 oil wells were pumped, but were not in continuous daily production. Gas was produced from 11 wells.

Oil is produced in Jackson, Cass, Atchison, and Platte counties, and gas from Platte and Clinton counties. Total footage drilled was 15,573 ft, all with cable tools.

Oil Sand 100 ft Thick

Southern California Petroleum and Trigood Oil's Barbour No. 1 on the northeast flank of the Del Valle field in the Los Angeles, California basin has cemented 7-in. pipe at 7125 ft. Total depth is 7315 ft. The project is credited with 100 ft of oil sand and appears to be running about 80 ft higher on structure than the Kinler No. 1 nearby. It offsets the Havenstrite Lincoln lease.

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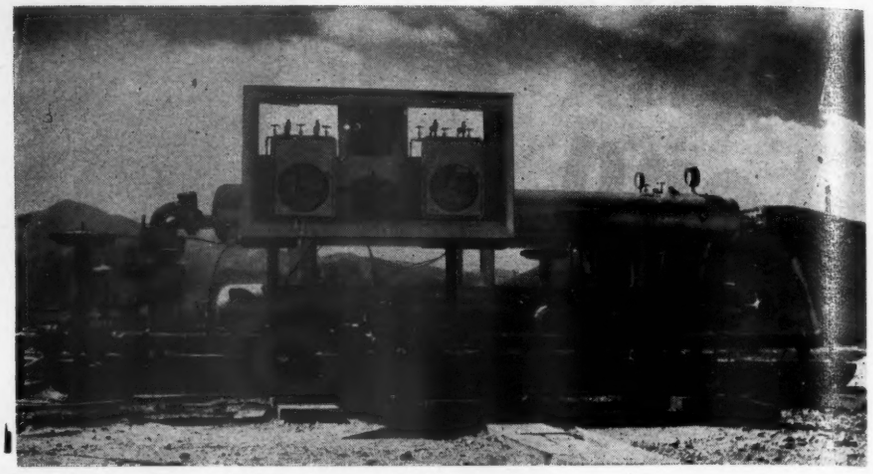


Separator Tests Wildcats. A new 2-stage, skid mounted, horizontal separator, supplied by American Pipe and Steel Corporation of Alhambra, California, is now being used for test purposes on certain wildcat wells of the Barnsdall Oil Company, near Newhall, California. The new units, which are readily moved from well to well, as needed, can be quickly disconnected because of the use of a minimum of fittings, and towed to the next location.

Pemex Enters Contracts

Petroleos Mexicanos has entered contracts with two American companies for exploration. Each will be working on a 25-year contract similar to that made with the Mexican-American Independent Oil—which has discovered oil off the East Coast.

Sharpless Oil Company, Denver, Colorado will work in an area paralleling the famous "golden lane" district along the East Coast. A group headed by Edwin Pauley, Los Angeles, California and the Independent Exploration Company, Bakersfield, California will begin work in northern Tamaulipas state, near the Reynosa field, across the border from McAllen, Texas.

Oatsville Pool Deepened

A new and deeper producing zone has been discovered in the Oatsville pool about five miles northwest of Oakland City, Indiana in Pike County.

The well is the Warren Usrey and John Organ No. 1 Belcher, which has been drilled to a total depth of 2100 ft. A one-hour drillstem test recovered gas in one minute 120 ft of clean oil and 120 ft of oil cut mud.

Completes Montana Gas Well

A 13,300,000-ft gas well has been completed in Glacier County, Montana by the Hannah-Porter Company. The well, Harder No. 1, was bottomed at 2712 ft in Ellis, reached at that depth. Cut Bank was topped at 2665 ft. The company moved about half mile north of the Harder No. 2.

Good Snyder Wells In

Two more good producers have been completed in the Snyder pool of Scurry County, Texas. Skelly Oil Company's No. 1 McLammy, with total depth 7008 ft, flowed 2739 bbl of oil in 24 hr, and its No. 6 Parrish flowed 1527 bbl of oil in 24 hr from the Upper Strawn sand and 385 bbl in the same period from the Lower Strawn. It was dually completed. Total depth is 7502 ft.

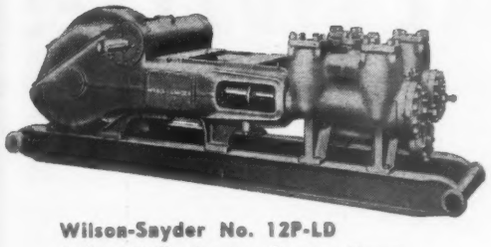
Velma Pool Extended

The Velma pool in Stephens County, Oklahoma is still being expanded by Stanolind Oil and Gas Company. The company's No. 1 Newman-C perforated casing with a series of holes 5851 and 6049 ft, and flowed 120 bbl of crude in 4 hr through 1-in. choke.

War Boosts Drilling

The Texas Railroad Commission received a record-breaking 640 applications to drill oil and gas wells in the week ended July 22. That is twice the usual number and more than three times the average for the first two weeks of July. Jack K. Baumel, chief engineer, reasons that oil men hope to get wells down before the government starts allocating steel.,

Drilling applications since January 1, 1950 number 10,612, an increase of 2377 over the corresponding period last year. Texas operators have discovered 318 oil fields this year, 54 more than a year ago; 41 gas fields, a decline of 18. They have completed 5847 oil wells, 977 more than in 1949, and 431 gas wells, an increase of one.



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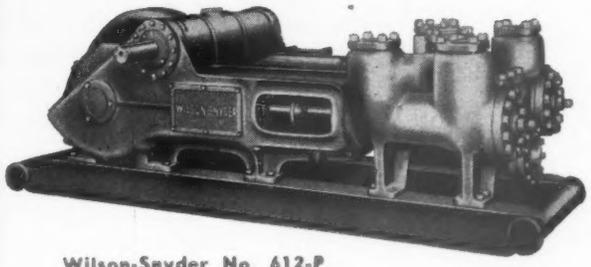

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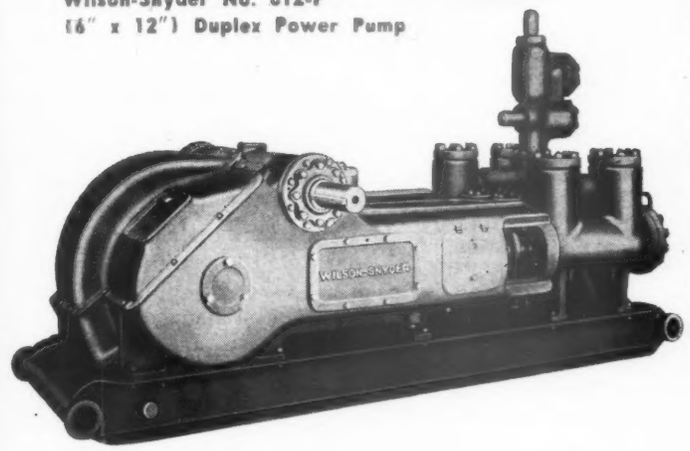
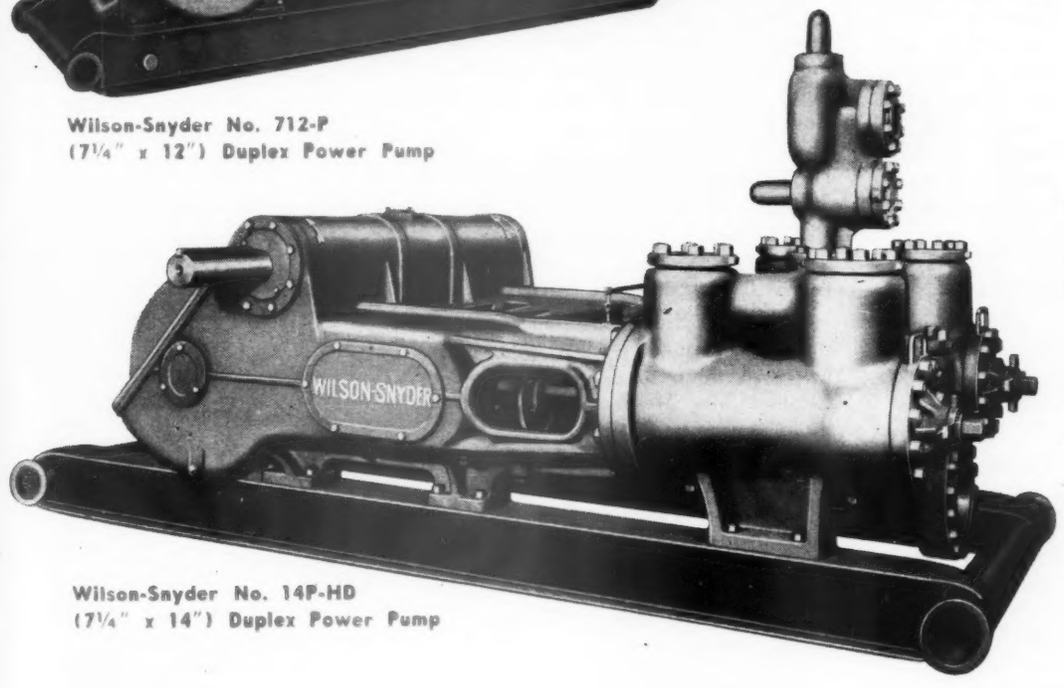
8P-HD	5" x 8"	3000	600	80	205	85
12P-LD	6" x12"	2000	365	70	395	100
612-P	6" x12"	3000	520	70	390	140
712-P	7¼"x12"	3000	550	70	580	220
14P-HD	7¼"x14"	4000	765	65	620	325



Wilson-Snyder No. 712-P
(7¼" x 12") Duplex Power Pump



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EXPLORATION ACTIVITIES

Seaboard to Explore Near Cat Creek Field

Seaboard Oil Company of Delaware is testing a new area in Montana near the Cat Creek field, which has been overlooked by geologists for 25 years because of the rough terrain that hides it. The new area, Sand Creek Dome in Garfield County, is being tested in the hope that this may prove to be the structure that has been the source of the unusual high-gravity crude oil in the Cat Creek field proper.

Seaboard is spudding a 5800-ft Madison test on U. S. acreage. According to some theories, somewhere on the flanks of the anticline will be found a large pool, with oil somewhat lower in gravity than that in the Cat Creek field proper. Observers believe that this pool has been the source of all the oil so far found in the Cat Creek field, and it will be found to be more prolific than Cat Creek.

Makes Strike in Logan County

Logan County, Oklahoma has a new pool discovery at Robert M. Jordan's No. 1 Carum. Pool opener is 3 miles south and 6 miles east of Guthrie, and is drilled to a total depth of 5910 ft. The well perforated the Wilcox sand between 5790-96½ ft, and flowed 116 bbl of oil in 4 hr through a ¼-in. choke. It will test the Bartlesville sand through perforations between 5340-48 ft.

To Test in North Dakota

A permit to test for oil in Mercer County, North Dakota has been issued to H. F. Kelly, Sinton, Texas. Operations are to begin shortly.

Find Tyler County Field

A new field has been discovered in Tyler County, Texas 10 miles east of Warren and five miles south of the East Hillister area. Officially named the Housh field, the discovery well is the No. 1 Charles Kieke, drilled by Housh Drilling Company.

The well was completed at a total depth of 8400 ft, and production is from the Wilcox between 8376 and 8384 ft through 48 perforations. On a 24-hr potential test it produced 181.5 bbl of 42 gravity pipe line oil through 9/64-in. choke. Casing was packed off and tubing pressure was 1500 lb. Gas-oil ratio was 1618 to 1.

Coke Well Opens Field

A new field has been opened in Coke County, West Texas. Union Oil Company of California has completed its No. 1-B Daisy McCutcheon to open a new Pennsylvanian sand zone field. The well flowed 179 bbl of oil a day through a ¼-in. choke, with pipe perforated at 3925-67 ft. The wildcat was drilled to dry Willenburger at 6295 to 6685 ft, total depth.

Prove New Oil Pool

McElroy Ranch Company has opened a new field in Stephens County, Texas at its No. 1 Glenn Taylor. The new field is situated 9 miles west of Breckenridge and 3½ miles southeast of the same operator's No. 1 Green, a Mississippi zone producer.

The wildcat flowed 220 bbl of 41.1 gravity oil on potenial test from the Mississippi lime at 4062 to 4158 ft, using an 11/64-in. choke. Gas-oil ratio is 1275-to-1. Mississippi reef was topped at 4065 ft, with elevation of 1218 ft.

Report Georgia Test

The Georgia State Oil and Gas Commission has reported that H. L. Chapman is drilling a wildcat at No. 1 W. P. Scott in Decatur County of West Georgia. The well, No. 1 W. P. Scott, is close to the Florida line. A rotary rig is being used that could drill to 7000 ft. At last report the well had reached a depth of 500 ft.

New Mexico Pool Found

McAlester Fuel Company has apparently opened a new Wolfcamp, lower permian lime, oil pool in Lea County, New Mexico. The well is 15 miles north of the Denton pool, and is designated the No. 1-A Brownfield.

A 25-min test from 9575 to 9734 ft showed gas to the surface in 6 min estimated at 2,000,000 cu ft daily, with recovery of 1870 ft of oil.

Nevada Test May Reach 10,000 ft

Continental Oil Company has announced that a depth of at least 10,000 ft will be reached if necessary in Nevada's first major oil well test. Test well is situated in southwestern White Pine County, 65 miles south of Ely. Officials report that oil of paraffine base has been found in small quantities in the test well area.

Plans to Explore British Columbia

Large scale oil exploration is planned for British Columbia, Canada's most westerly province, hitherto unknown as a location for oil. Most of the land that has been tested or is being tested by geologists is situated in the northeast corner of British Columbia near the Alberta border.

Sixty miles into Alberta British-American Oil Company—Shell discovered Whitelaw No. 1, termed one of the biggest wells in Alberta's history. A British-American company official has reported that survey crews would examine the land this year, and begin drilling by 1951.

Drill Indiana Wildcat

Illinois Mid-Continent Company's H. C. Ford No. 1 has been brought in in Posey County, Indiana as a producer.

The well was drillstem tested in the Clore sand to get 30 ft of gas, 195 ft of oil, and 90 ft of oil cut mud, J. Roy Dee, general manager of the company announced. Estimated production was placed at about 50 bbl a day.

Dee also reported that Carter Oil Company expects to carry the drilling to the deeper zone in a plan to prove up other sand formations in the area. The wildcat is situated on a farmout from Carter Oil.

Make Two Canadian Strikes

A Lower Cretaceous gas strike has been made 15 miles east of the Stettler oil field in Calgary, Canada by the Canadian Superior Oil Company. The company's Liebing No. 8-24 wildcat received a flow rating of 2,675,000 cu ft a day in the Cretaceous interval, 4125 to 4208 ft. Total depth is 5639 ft.

Canadian Superior was formerly known as Rio Bravo Oil Company and is subsidiary of Superior of California.

Socony Vacuum Exploration Company also has a wildcat in that area, 15 miles southwest of Leduc production. Its Sunnybrook No. 1 wildcat received showings of natural gas and oil giving encouragement in the D1 zone of the Devonian and is now being deepened to test D2 and D3 zones. In a test of the interval 5695 to 5717 ft, natural gas hit the surface 12 min after the tester was opened and was measured at 71,000 cu ft daily.

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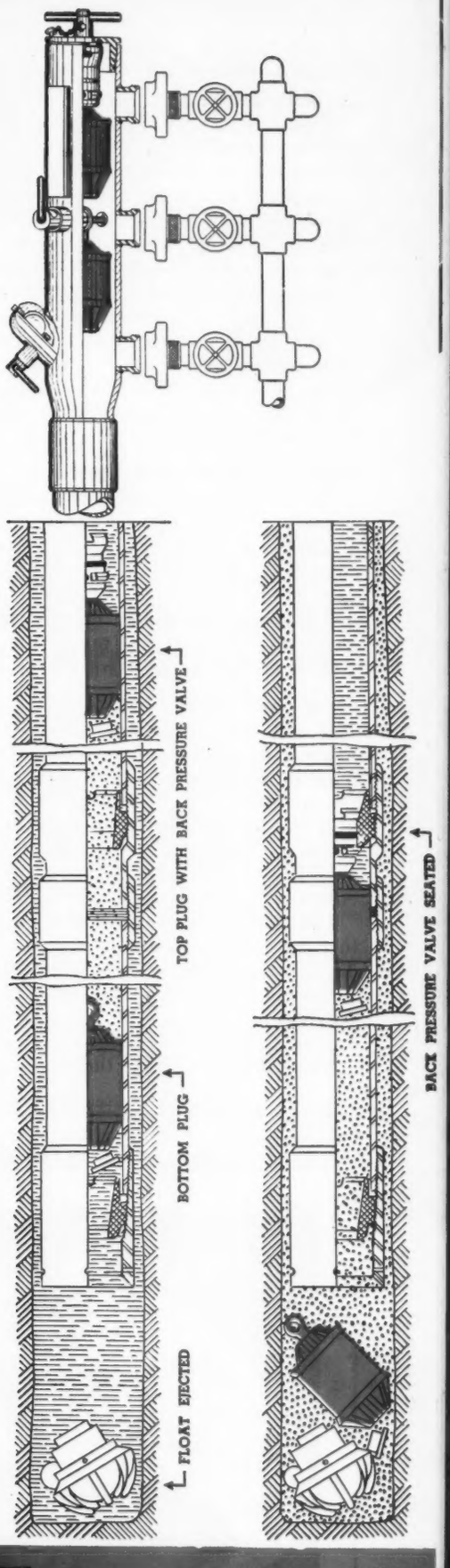

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Arizona Gas Well Drilling Ahead

Kipling Petroleum Company is still drilling deeper at its wildcat No 1. Hortenstein in Apache County, Arizona. A gas flow estimated at between 20 and 40 million cubic feet daily has been pronounced principally nitrogen with only a trace of hydrocarbons and helium content of about 7 per cent. The objective is commercial oil and gas that it is hoped will be encountered with deeper drilling.

On last report, test was bottomed at 1355 ft and spraying salt water over the derrick.

Superior Gets New Pool

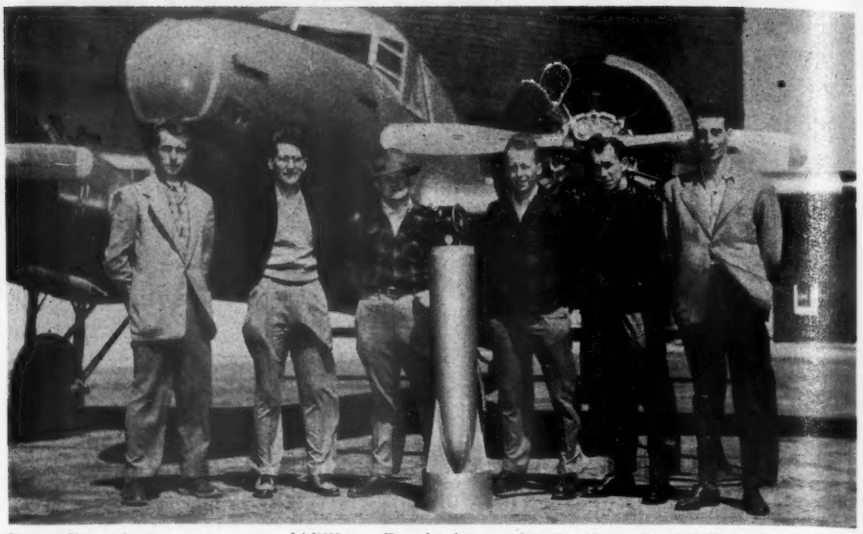
Superior Oil Company has opened a new oil field in South Louisiana, 1½ miles west of Grand Lake. The company's L-1 Miami Corporation flowed 140 bbl of 35.4 gravity oil daily through a 6/64-in. choke from 8890 and 8896 ft. Tubing pressure was 1350 lb and gas-oil ratio was 427 to 1.

New Reef Zone Field

A new reef zone field has been opened by Amerada Petroleum Company in Terry County, West Texas at the company's No. 1 Willard. It is a mile west of the deep Adair field, and six miles southeast of the Anderson-Prichard Oil No. 1 Bevers, a reef discovery made earlier.

On a 5-hour drillstem test at 8480 to 8507 ft, the Willard flowed oil in 33 min and after cleaning into pits, tanked 144 bbl of oil in 4 hr, with gas-oil ratio of 431-to-1. The well was begun as a 12,000 ft test, but it may be completed without going that deep.

Alberta, Canada, Gets Aerial Magnetometer Survey



Canadian Aero crew are: William Ferderber, chief pilot; Jack Webster; Robert Pate, magnetometer operator; William McLaughlin and James Fox, data analysts, and Sam Taylor, pilot.

The tempo of the oil search in northwest Alberta received new impetus recently when the first large scale airborne magnetometer survey of the Peace River area was begun for four major oil companies by Canadian Aero Service, Ltd. Because of the large expense of the operation, and because of the general nature of the data that will be obtained, the survey is being undertaken on a cooperative basis by Socony Vacuum Exploration Company, Stanolind Oil and Gas Company, Imperial Oil, Ltd., and Canadian Gulf Oil Company. Other oil companies have been invited to participate in the survey to extend the area of the operation, and it is believed there may be a fifth and possibly sixth company sharing in the exploration in the near future.

The aerial method is especially useful in the Alberta survey because the greater part of the area is heavily forested or muskeg country. Ground exploration is therefore slower, more costly, and more difficult than usual.

According to Thomas M. O'Malley, president of Canadian Aero Service, Ltd., one or two twin-engine planes* will be used in the survey. The planes have been outfitted as complex flying laboratories. Their equipment includes a precise aerial mapping camera, a continuous strip camera, which records the path of the plane during the magnetometer survey, and several electronic recording devices. The Gulf airborne magnetometer will be used for the survey.

The survey will be flown at an altitude of 1000 ft in a series of parallel lines spaced at 1½-mile intervals, with many intersecting control lines to correct for the severe daily variations of the magnetic field found in this part of the world. Over 16,000,000 acres will be mapped.

Magnetic maps will be compiled at a scale of one mile to the inch, with a 5 gamma contour interval. The magnetic record will be 2 gamma, only 1/25,000ths as great as the earth's magnetic field being measured.

Jack C. Webster will be project engineer for the survey. Aero Service Corporation of Philadelphia, Canadia Aero affiliate, will lend some technical assistance, and Spartan Air Services, Ltd., of Ottawa, will provide the plane and flight personnel for the survey.

*Anson.

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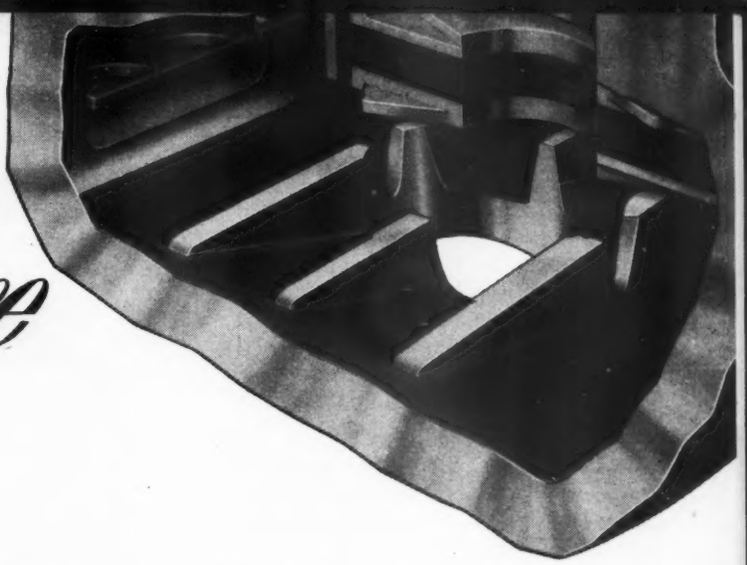

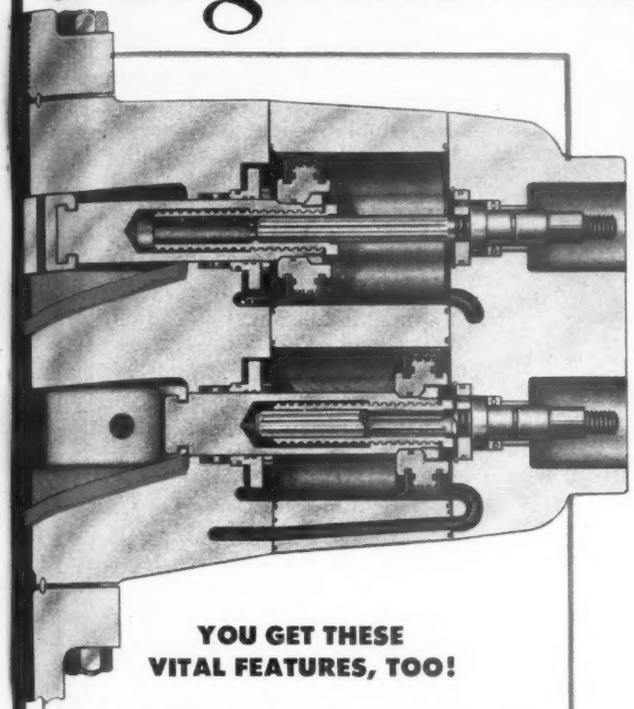

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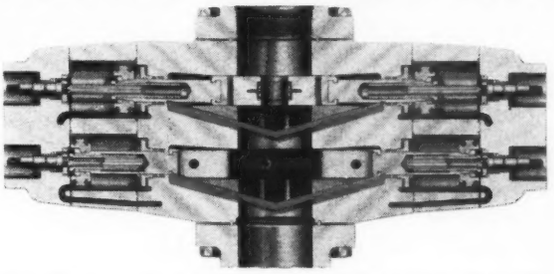

Besides its many other important features, the new Shaffer Hydraulic Cellar Control Gate incorporates an important advantage found in no other hydraulic cellar control gate. Note how the bottoms of each ram compartment are steeply-sloped toward the bore—*with high, narrow ribs upon which the rams travel.*

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In addition, because these ribs are *high* above the steeply-sloped bottoms of the gate, they hold the rams far above any mud or sand that might collect on the bottoms of the ram compartments.

As further protection, note how the bottoms have a steep inward pitch that quickly drains mud and sand back into the well as quickly as it settles. With this three-way protection against detrimental mud and sand, the rams are *always* ready for use whenever pressure emergencies threaten!

Then remember this—mud-free design is only one of *many* far-reaching advancements built into the new Shaffer Hydraulic Cellar Control Gates. Check over some of the others outlined at left. No other equipment provides so *much* protection—in so *small* a space—with so *many* operating advantages!

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▸ **FULLY ENCLOSED DESIGN**—with all moving parts enclosed and no moving parts on the outside to become wedged or damaged by objects falling into the cellar—or become corroded by chemical and salt drippings. Even the locking shaft is non-rising and fully protected!

These and still other vital advantages make the new Shaffer Hydraulic Cellar Control Gate *the* outstanding hydraulic gate available today. Before you buy *any* control gate equipment, be sure to get the *complete* story from your nearby Shaffer representative. Or write direct!

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See pages 4433 to 4496 of the 1950 Composite Catalog.

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▸ **Donald D. McGirk,** senior field geologist for Texas Petroleum Company has been transferred from the Venezuelan to the Colombian division in that capacity. **J. F. Tindol,** who has been district superintendent for the company at Maracaibo, has returned to the United States, and has been succeeded in Maracaibo by **R. E. Wright.**

▸ **R. L. Walker,** Shell Oil Company has been advanced from regional mechanical engineer to Houston, Texas area drilling engineer.

C. M. Chappell, computer, was named junior geologist; **E. G. Christianson,** division exploration engineer, New Orleans, has been transferred in the same capacity to the East Texas division; **C. J. Frazier, Jr.,** mechanical engineer, has joined the regional production staff; **Hal J. Jones,** has been reemployed as junior geologist on the regional gas-engineering department exploration staff; **E. B. Lagucki, Jr.,** mechanical engineer, transferred to the East Texas division from the regional staff.

F. W. Roberts, design draftsman, **F. A. Schurtz,** division-production geologist Tulsa area staff, was made regional exploitation engineer, and **W. O. Wottlin, Jr.,** geophysicist, regional exploration staff, was named Houston area geophysicist.

▸ **C. W. McBride,** Phillips Petroleum Company, has been elected president of the Texas Gulf Coast Oil Scouts and Landmen's Association. Other new officers are: **B. E. Maxwell,** Humble Oil and Refining Company, and **J. F. McCall,** Amerada Petroleum Company, vice presidents; **T. E. Weatherly,** Pure Oil Company secretary-treasurer; **George O. Cate,** Humble, year-book editor; and **R. C. Pettit,** Houston Oil Company of Texas, delegate.

▸ **H. Ross Bolton,** formerly petroleum engineer for Ohio Oil Company's Terre Haute division, was appointed chief engineer in Deep Rock Oil Corporation's production division. Bolton replaces **K. W. Haley,** who resigned from the position recently. Bolton received his engineering degree from the University of California. Following graduation, he began work as roustabout in Ohio Oil's Bakersfield district and worked up to be district petroleum engineer before being transferred to Oklahoma in 1947 as engineer of the Tulsa producing division.

▸ **A. E. (Sandy) McKay** has been appointed executive vice president of Southern Geophysical Company in Fort Worth, Texas. McKay goes to

A. E. McKay

Fort Worth from Dallas, where for the past 6 years he has been assistant chief geophysicist for the Atlantic Refining Company. He has been actively engaged in oil exploration since he received his Bachelor of Science degree in geology from the University of Oklahoma in 1928.

His first position was with the Indian Territory Illuminating Oil Company of Bartlesville, Oklahoma, and he served this company until 1937 when he joined Atlantic. McKay is an active member of the American Association of Petroleum Geologists, Society of Exploration Geophysicists, American Geophysical Union, and the Dallas Geophysical Society, of which he was first president.

▸ **Daniel C. Nufer** will open offices in the Atlas Life Building as an independent consulting geologist. Nufer resigned recently as area geologist with Deep Rock Oil Corporation. Before joining Deep Rock, he worked with Carter Oil and Burke-Greis Oil Corporation.

▸ **W. C. Whaley,** recently elected vice president and director of Sunray Oil Corporation, has been named to direct the California division, which will be referred to as the Barnsdall division of Sunray. **R. E. Foss** has been named manager of production and drilling operations; **H. L. Stine** will serve as assistant secretary and office manager; **J. S. Loofbourow** will be chief geologist; **F. A. Fueller** will be manager of land operations; **T. J. Casey** is counsel, and **R. A. Smith** will serve as attorney.

Headquarters will continue in the former Barnsdall offices in Los Angeles' Petroleum Building.

▸ **E. E. Hagan,** The California Company, has been transferred to the Hico-Knowles area as engineer in charge, from the company's Natchez, Mississippi production office.

Changes in the production department, North Louisiana-Mississippi division include:

J. R. Black, Jr. to Lake St. John, Louisiana; **R. P. Dwyer,** engineering staff New Orleans, to North Louisiana-Mississippi division, Cranfield, Mississippi; **J. R. Meason,** to Gulf Coast division, Harvey, Louisiana; **T. P. Peyton, III,** from Brookhaven, Mississippi to Cranfield; **H. A. Trueblood,** from Natchez to the Gulf Coast division; **V. A. Walter, Jr.,** from Cranfield to Lake St. John, and **W. D. Wilkinson,** Lake St. John to Mid-Continent division, Ardmore, Oklahoma.

In the western division, production department changes include:

A. R. Cook, Neibor dome to Rangely, Colorado; **W. G. Cutler,** from Wilson Creek to Gulf Coast division; **H. J. Haynes,** Denver, Colorado to North Louisiana-Mississippi division, Natchez; **W. T. Hudson,** staff assistant, exploration, Denver; **J. R. Lynch,** Rangley to Wilson Creek; **J. L. Martin,** Quealy dome to Rangley; **J. C. O'Connor,** Casper, Wyoming to Rangley; **F. H. Sievert, Jr.,** Gulf Coast division, Harvey to Barataria, Louisiana.

In the exploration department, **G. P. Stewart** has been moved from Denver to Casper, and **W. A. Tarleton,** eastern division, Lexington to production, Gulf Coast division, Harvey.

▸ **Hugh R. Brankstone** has been appointed employee relations advisor at the Fort Worth production division of the Gulf Oil Corporation.

Brankstone was reared in the Pittsburgh area and following his graduation from the University of Pittsburgh with a degree in geology he joined the Gulf Companies as a member of the general office geological department. He was appointed assistant to the employee relations advisor of the production and pipe line department in 1947.

▸ **O. B. Jordan** has been transferred from Magnolia Petroleum Company's Falfurrias, Texas producing district, where he was assistant production superintendent, to assistant superintendent of the Brownfield district. His headquarters will be at Snyder, Texas.

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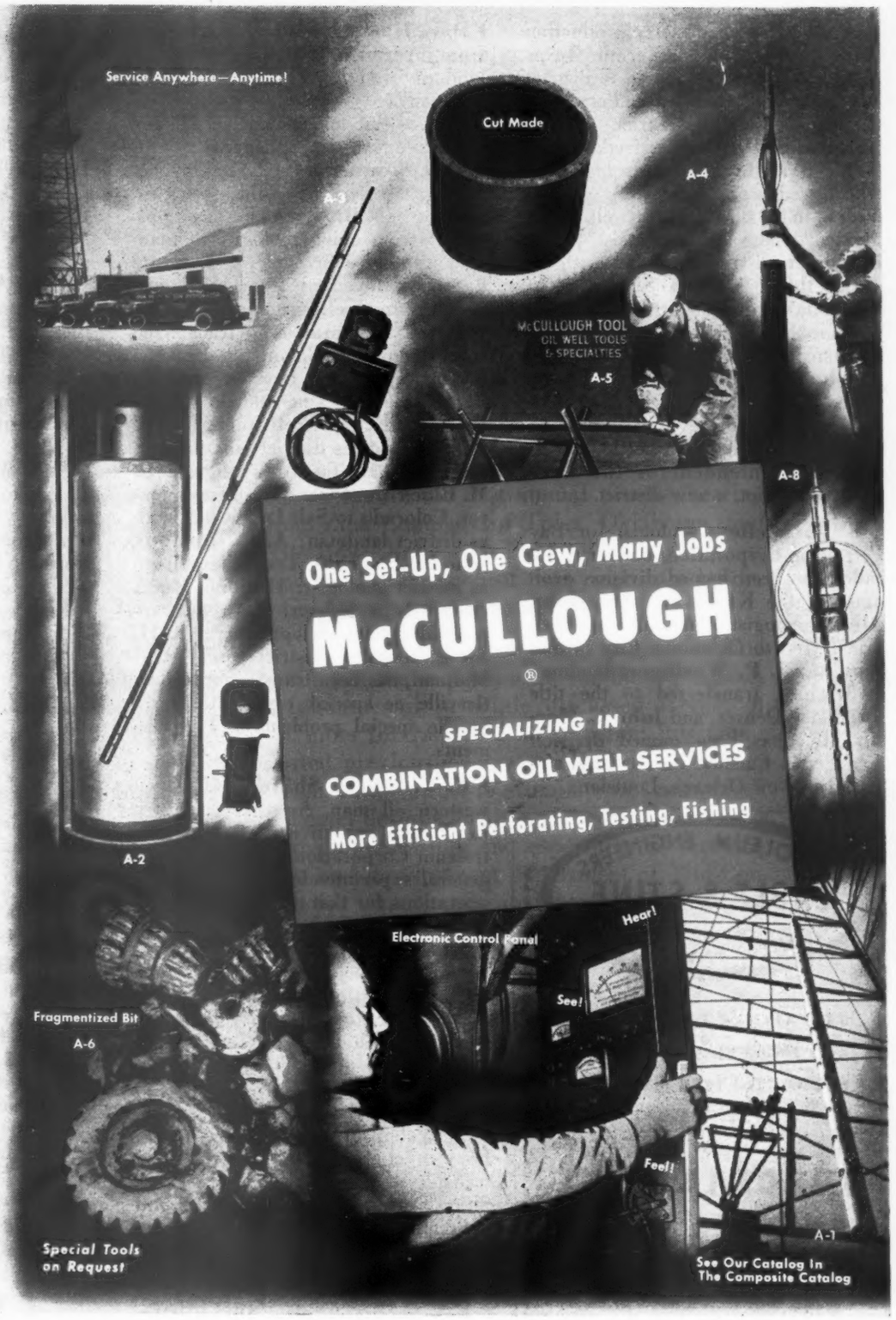

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▸ **G. L. Nelson,** formerly production superintendent in the Kermit, Texas district, has been promoted to district superintendent of Magnolia Petroleum Company's Pampa district. He replaced **J. S. O'Brien,** retired.

W. Brantley Jackson has been transferred from Magnolia's general offices in Dallas to Roswell, New Mexico, where he will assist **S. P. Hannifin,** district land man, with his duties there. **Marvin S. Jones** of Magnolia's land department in San Antonio has been transferred to the company's general offices in Dallas.

John E. Shannon has been promoted from assistant superintendent of the Lake Charles and Louisiana Gulf area, Vanderbilt district, to district superintendent of the Lake Charles district, a new district.

▸ **R. A. Shelley,** geologist for Bay Petroleum Corporation, Denver, Colorado, has been named division geologist of the Kansas division. **John Allen,** geologist at Wichita, has been transferred to Oklahoma City in that capacity; **J. P. Wasinger,** landman at Wichita, transferred to the title division at Denver, and **John C. Martin, Jr.,** has been named division manager in Canada. He has been stationed in New Orleans, Louisiana.

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▸ **D. C. Hamsell** has been transferred from superintendent to manager of the land division for Phillips Petroleum Company.

Other personnel changes in the land and geological department are:

D. E. Lounsbery will remain chief geologist in charge of the geological division; **W. B. Weeks** has been promoted from chief geologist to manager, geological section; **A. J. Hintz** has been advanced from chief geophysicist to chief seismologist.

N. H. Newman was transferred from Ardmore, Oklahoma, to Houston as district landman; H. S. Knight from Bartlesville to Evansville as district landman; **R. I. Sewell** from Midland to Shreveport as district landman, replacing **L. B. Tucker,** resigned. **B. M. Blackmore** transferred from Denver, Colorado to Salt Lake City, Utah as district landman; **A. C. Hornady** from Wichita Falls, Texas to Amarillo as district geologist; **Handris Haig,** stationed in Denver, has been appointed district geologist there. **M. H. Steig,** formerly district geologist at Midland, has been transferred to Bartlesville as special representative to handle special problems and assignments.

▸ **R. R. "Dick" Shinn,** well known western oil man, for many years a production executive of General Petroleum Corporation, and since 1946 general superintendent of production operations for that company, died recently from injuries sustained in an automobile accident a short time before. He had been with General Petroleum Corporation since 1913 and had in the meantime occupied many responsible positions in the Los Angeles basin, coastal, and San Joaquin Valley areas.

Most of his time, however, was spent in the Valley, of which division he had been in charge since 1924. He was transferred to Los Angeles in 1944. Shinn was a member of Petroleum Production Pioneers, and active in many technical groups and associations.

▸ **F. C. Anderson,** Gulf Oil Corporation-Gulf Refining Company has been transferred from the Houston, Texas, producing division to the newly formed Fort Worth, Texas, producing division. He was formerly assistant to the vice president and assistant secretary of the two Gulf companies. **John S. Trail, Jr.,** will succeed Anderson in Houston.

▸ **Willis W. Hardy,** chief geophysicist since 1939 of the Socony-Vacuum Oil Company, Inc., has been appointed assistant chief of the company's exploration division.

▸ **Craig M. Rowley** has been transferred to Kiefer, Oklahoma as district engineer specializing in secondary recovery work for Sinclair Oil and Gas Company. **Ray Fickel,** geologist, has moved to Houston from Odessa, Texas. He will be succeeded in Odessa by **Don Gibson** of the Amarillo office. **Corwin Smith** will fill the Amarillo post.

▸ **Z. C. Ambrose,** vice president of Southwest Gas Producing Company, Inc., and Carbons Consolidated, Inc., Monroe, Louisiana, was elected president of a subsidiary company, Monla Gas Company, Inc., Monroe, Louisiana recently.

▸ **E. A. Markley,** formerly chief geologist for the former Barnsdall Oil Company, has been named senior division geologist and supervisor of exploration for West Texas, Abilene, and the North Texas districts of Sunray Oil Corporation. He will be working with **Don O. Chapell,** Tulsa, Oklahoma, vice president and manager of the exploration and land departments.

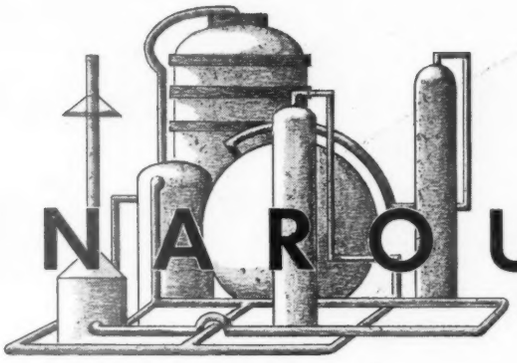
Marion J. Moore, has been named division geologist and supervisor of exploration for the South Texas Gulf Coast, Louisiana, and Mississippi districts. He was formerly Sunray district geologist at San Antonio. **Sherril A. Shannon,** was named division geologist and supervisor of exploration for Kansas, Oklahoma, and the Rocky Mountain states. He is former Sunray district geologist at Wichita, Kansas.

Harold G. Picklesimer, succeeds Moore at San Antonio. **Ralph C. Lamb** replaces Shannon as district geologist for Kansas. He was formerly district geologist for Barnsdall. **Robert O. Burkett,** geologist in Tulsa, has been transferred to Sunray's Midland, Texas office as geologist. **Karl F. Martin, Jr.,** formerly in the Tulsa office, was transferred to Midland as scout.

▸ **B. H. Treybig, Jr.,** has been promoted to assistant to division manager of the geophysical division, producing department, The Texas Company. Treybig, who will be stationed in the division office, Houston, Texas attended Rice Institute. He was employed by The Texas Company in 1932. After working in various jobs in the geophysical division, he was promoted to seismic party chief in 1936.

In 1939 Treybig served 6 months in Venezuela, where he had charge of the company's geophysical operations. He has been supervisor of geophysical operations in the Louisiana division, producing department, since 1941.

THE TURNAROUND



All Processing Begins With Heating

PRESENTED in this issue is a group of closely related papers on various phases of process heating. These papers were presented before the first annual process heating seminar, arranged and directed by the John Zink Company of Tulsa, Oklahoma, and presented in session in Tulsa on June 10, 1950. Robert D. Reed, chief engineer of that company, directed the preparation and the presentation of the symposium before more than 100 engineers from the Mid-Continent and adjoining areas.

Beginning on the basic principle that practically all processing is built around heating operations, the papers consider in detail the requirements for these purposes from 4 viewpoints. Probably the most fundamental principle discussed is that of methods for new approaches to design of units for radiant heat transfer; this paper by Robert D. Reed adds to the data reported previously by such research authorities as Manglesdorf, Hottel, McAdams, and Lobo, in the effort to eliminate or "minimize" various troublesome difficulties in existing heater designs. Looming large in the refiner's lexicon, also, is the economics of any part of processing, and especially of recovery of waste heat. L. D. Stewart of the process and development department of Mid-Continent Petroleum Corporation discusses in his paper, presented herein, a wealth of detail of costs, values and returns from these operations, which will be of the greatest value to all operators and engineers interested in this field.

Metals and alloys are among the two or three most important factors involved in equipment, and the choice of alloys for use in corrosive conditions (that is, in high-sulfur crude processing) has even greater effect on refinery operations with the large increase in the amounts of high sulfur crude processed. Introduction of Middle East crudes as well as the use of West Texas and other high sulfur crudes accentuates the need for more information on better alloys for corrosion resistance. Francis Fahrenwald, head of Fahralloy Corporation and international authority on alloys for industrial applications, discusses the best products for use with such corrosive process materials and brings refiners up to date in this field.

As a part of the picture on waste heat recovery, J. H. Smith of Continental Oil presented the data to show the advantages and economies of using transeconomizers in thermal polymerization operations. This most practical paper "cites chapter and verse" in showing both how these units were installed, were operated, and the advantages and disadvantages obtained by their operation.

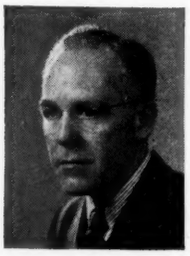
Unfortunately it is not practicable to include the fourth session, Question and Answer program, in which a dozen outstanding leaders in process heating acted as Information Panel to answer questions asked by interested inquirers. Robert D. Reed served as Quizmaster for this session, which brought out a great deal of detailed information, but in verbal form so that transmission to type cannot be made at present.

Arch L. Foster

New Facilities Boost Ohio's Gasoline Yield

By Harry E. Handy
Superintendent
Robinson, Illinois, Refinery
The Ohio Oil Company

An increase of 7,000 barrels per day in the crude capacity of our principal refinery at Robinson, Illinois, has been effected with the completion of an extensive expansion and improvement program.



Harry E. Handy

Enlargement of our facilities was necessitated by the steadily growing demand for our products. In addition to processing more crude than formerly, the new facilities have enabled us to reduce former fuel oil yields by approximately one-third while substantially increasing the yield of gasoline and middle distillates.

Include Fluid Cat Cracker

The new facilities, process designed by Universal Oil Products Company, include a 27,500 b/sd two-stage crude distillation unit, a 12,400 b/sd UOP fluid catalytic cracking unit, a UOP catalytic-polymerization unit, a gas recovery system and a gasoline treating plant. Auxiliary facilities required as a result of the expansion of processing units included a water-circulating pump house, a cooling tower, a power house extension, 1,250,000 barrels of new tankage, an Ethyl blending plant and an A.P.I. oil separator.

The new processing equipment was installed as an integrated refinery area on a completely new site, thus allowing for economies in operating and maintenance which would not have been possible had the old equipment been combined in a revamp. Furthermore no costly shut down time was involved, as the old facilities could be operated up to the startup of the new plant.

The crude distillation unit includes facilities for atmospheric distillation, vacuum distillation and oxidizing or air blowing of asphalt. The crude oil passes through a desalter before entering the prefractionating column of the atmospheric unit.

Unit Simple in Design

The fluid catalytic cracking unit is of the latest design in which the regenerator is placed below the reactor and operates at approximately 15 psig. This made it possible to reduce the diameter of the regenerator 30% compared to a unit in which regeneration is carried out at approximately atmospheric pressure. It also resulted in elimination of the spent catalyst risers, which was one of the most troublesome lines in the wartime plants from the standpoint of maintenance.

A New Approach to Design for Radiant Heat Transfer in Process Work

ROBERT D. REED

THE subject of radiant heat transfer in process heaters, having provided the cause for so many researches by so many brilliant men who have established data upon which process heaters have been designed for so many years may seem a little beyond the pale. It has been only after years of work and after very careful consideration of the subject matter that determination to present the evidence herein contained has been reached.

We hasten to say that contradiction of existing data is far from the intent of this paper. We hope, instead, to provide evidence that another factor should be added to the existing and well-proven equation to more accurately predict the performance of process heaters and to eliminate certain disadvantages that may exist.

In establishing the radiant characteristics of a furnace 3 important factors are considered. They are: 1. Radiation from the flame bursts of the burners; 2. Radiation from hot refractory planes, and 3. Radiation from the CO_2 and H_2O contents of the flue gases. Hottel has indicated that consideration be given to a certain convection factor and engineering companies include this factor particularly at the point where all the flue gases are gathered at the exit from the radiant portion of the furnace.

A very authoritative research on the extent of radiation from flame bursts was made by von Helmholtz who determined the values of radiation from flames when burning various gases in air. Helmholtz found that the amount of radiation per unit volume of gas burned depended upon the kind of burner used, the size of the flame, the amount of air mixed with gas before burning, the temperature of the gases before combustion and principally upon the kind of gas being burned. His values for the amount of energy radiated by the flame ranged from 5 to 15 per cent of the total.

A later research by Haslam, Lowell, and Hunneman has shown that the amount of heat radiated by a flame varies according to the amount of primary air mixed with the gas before combustion. Greatest radiation was found when an amount of air equal to theoretical air or the volume of air theoretically required to burn a unit volume of gas was present as primary air. When the volume of primary air exceeded theoretical or was less than theoretical a decrease in radiation from the flame was noted.

We have found in the course of experiments in our laboratory that there is a very definite relationship between the H/C ratios by weight of gases and the relative abilities of flames made by them to radiate. Although the following information is not precise because of certain inadequacies in experimental technique we have found that the abilities of flames made by two fuels to radiate vary as the square of the ratio of their relative H/C ratios by weight. As an example: Consider the relative radiant abilities of methane (H/C — 0.33 and butane (H/C — 0.208). $\frac{.33}{.208} = 1.586$ which when squared equals 2.51 therefore the radiant factor for butane will be found approximately 2.51 times greater than the radiant factor for methane.

PROCESS HEATING SYMPOSIUM

This is the first of four papers that are included in the first annual symposium on process heating. Here are outlined such important considerations as radiation surfaces, recirculation of gases, tube and wall spacing, all of which affect heater design and operation.

No data that are available on research as to the ability of flames to radiate show more than 15 per cent of the total heat being dissipated by the flame burst alone. It should be pointed out that the researchers have dealt only with clear blue flames and factors for radiation have been established on that basis. Radiation from yellow or luminous flames may be from 19 per cent greater to 225 per cent greater but because of the requirement for so much more room for burning gas with yellow flame which increases furnace costs all out of reason blue flame burning has been accepted as standard by the process industries. The almost universally held opinion that yellow in a flame is an indication of inefficient burning is completely fallacious unless the yellow flame is caused by lack of enough air to complete combustion. Some yellow in the flames made by burners at considerable excess air will actually increase the efficiency with which a furnace runs because of the improved radiation of heat from the flame.

Where oil is being burned the radiant factor from the flame is tremendously greater than that for gas because in addition to the fact that the oil burns with a brilliantly luminous flame it has a H/C ratio of 0.10 to 0.15 to further increase its ability for direct flame-burst radiation.

Factors for radiation from refractory planes to absorptive surfaces in the heater are quite easy to arrive at and no comment seems required except to say that later in the paper we shall raise the issue of the sources of heat for these planes in detail.

Factors for the third element in the radiation equation may be obtained from the well known and accepted Black Body Reference Curves for radiation due to CO_2 and water vapor in flue gases based upon the partial pressures of the CO_2 and H_2O and the average length of the radiant path through the gases in feet as plotted by Mangelsdorf and others in a brilliant series of experiments.

We now arrive at a point where we find that 5 to 15 per cent of the total heat energy is available from the flame burst and as experience seems to show that the mean 10 per cent is a very good average figure to use we may consider that 90 per cent of the total heat remains either to be absorbed or

to be lost to the stack. A good average figure for thermal efficiency on furnaces of current design would be 70 per cent on the gross heat basis before radiation loss is considered and where latent heat loss to the stack due to the burning of the H_2 in the gas will average 8.5 per cent.

Common practice is difficult to establish in the percentages of heat absorbed in the radiant sections and convection sections of furnaces but a fair average would be 80 per cent of the total in the radiant section and 20 per cent in the convection. Since we absorb only 70 per cent of the total heat made available by burning the fuel it is to be seen that 56 per cent of the total heat is absorbed in the radiant section and 14 per cent of the total heat in the convection section.

If we accept as true that 10 per cent of the total heat is absorbed in the radiant section directly from the flame burst we shall be in error because the flame is not completely surrounded by absorptive surfaces. A large portion of the heat to be realized from direct flame-burst radiation is directed to refractory surfaces and re-radiated to the absorptive surfaces therefore we have one source of heat for the refractory planes of the furnace but a source which seems capable of delivering only 10 per cent of the total heat. Another source of heat for the refractory planes is the sweep of hot gases away from the burners but because of strict limitation as to overheating transfer surfaces this source is limited in its scope as to reaching all the refractory surfaces of the furnaces which is to say, of course, that the fact that the flame has stopped at a point in its progress is no indication that gases proceeding forwardly from the point where the flame stops instantly reach mean ambient temperature.

The Author

Son of an Oklahoma oil driller and steeped in petroleum since his birth, Robert DeHart Reed is chief engineer of the widely known John Zink Company. He engineered the first annual process heating seminar held in Tulsa June 10, 1950. Robert began with John Zink in 1936 as a draftsman, and he has devoted all his professional time since then to heat production and methods and means for producing heat. Earlier he graduated from Sapulpa, Oklahoma High School, and Oklahoma A & M College. He then worked as chemist for the old Navajo Refining Company, and for Continental Oil Company, and even made a brief foray into petroleum journalism for the *Tulsa World*, Oklahoma daily newspaper. He has written many technical papers for journals and for technical societies, and is known widely as a speaker, lecturer in his field.

The Black Body Reference Curves as mentioned provide a further source of heat to both the absorptive surfaces and the refractory planes but it is significant to note that the curves consider only the CO_2 and H_2O in the gases because neither nitrogen nor oxygen has appreciable radiation characteristics.

The percentage of the total heat made available for radiation by the CO_2 and H_2O is amazingly small as is shown by the following pound-mol equation for the combustion of methane at 50 per cent excess air and the heat content of the products of combustion:

CH_4 plus $3O_2$ plus $11.28N_2$	=	CO_2 plus 33,800 Btu 9.8%		$2H_2O$ plus 55,000 Btu 15.95%		O_2 plus 21,000 Btu 6.1%	$11.28N_2$ 235,000 Btu 68.15%

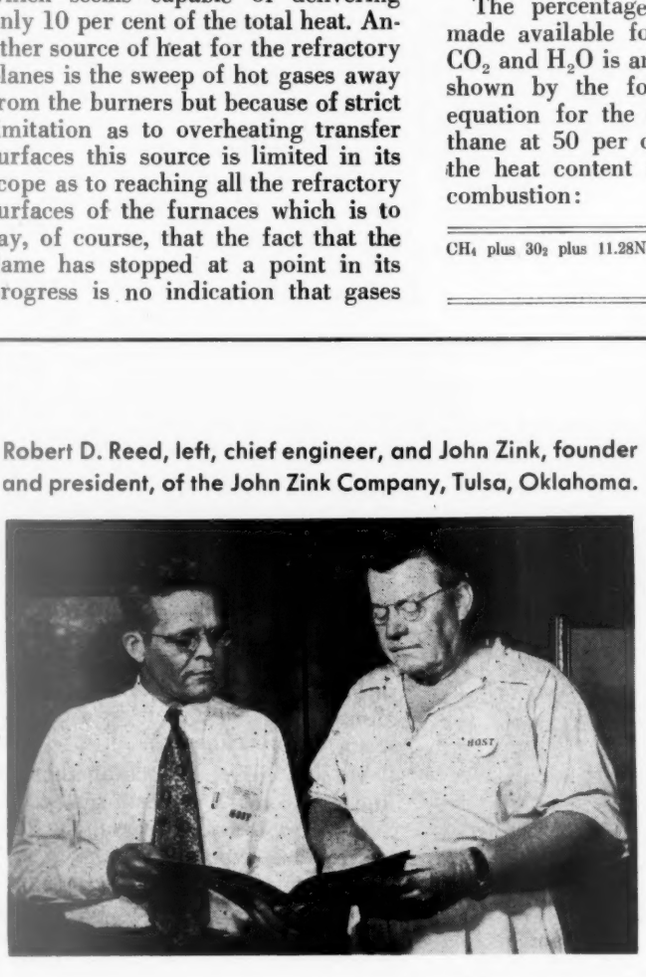
We have consulted with many new authorities on atomic and molecular functions and a consensus is that, in average conditions, from 20 to 40 per cent of the heat content of the nitrogen could be conducted to the CO_2 and H_2O through molecular collisions to make the heat available by radiation to the refractory planes and the absorptive surfaces of the furnace. As time, turbulence, and the proportions of the furnace are variables in the extraction of the heat from the N_2 a concensus favors the extraction of about 25 per cent as a very good mean for current furnace design.

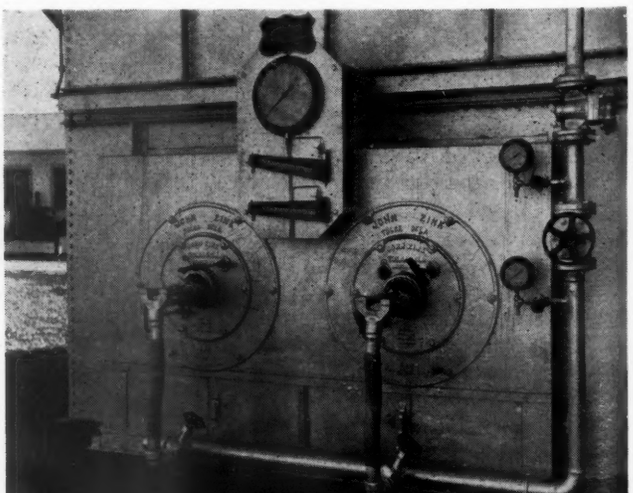
If we accept the foregoing as true then it is apparent that approximately 54.31 per cent of the total heat made available by burning the fuel is available by radiation, which is not at all to say that all the heat thus made available is absorbed by the transfer surfaces because of certain laws and considerations governing the rate with which radiant energy as heat may be absorbed from various sources.

To begin with, it is impossible to hold the flue gases inside the furnace until a condition of equilibrium in temperature has been reached between the flue gases and the absorptive surfaces. For that reason alone it is evident that a very appreciable portion of the heat available by radiation is lost in moving the gas out of the furnace before it has exhausted its supply of radiant energy.

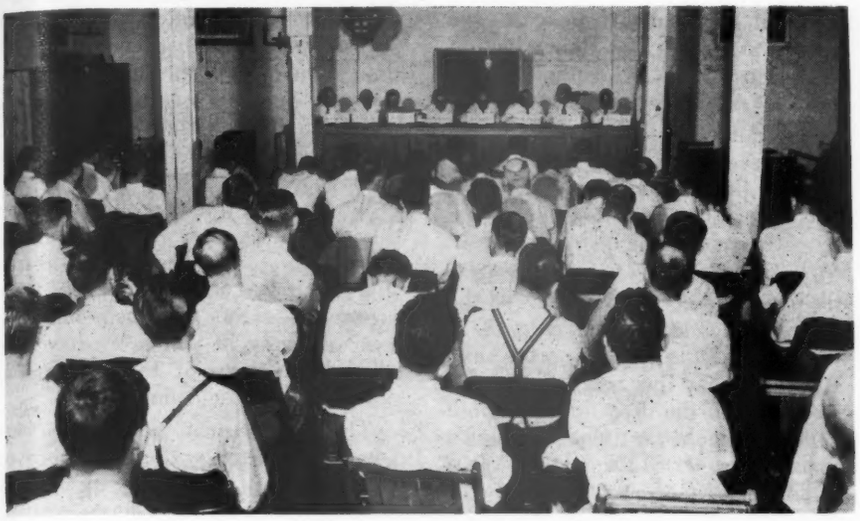
As an example let us consider a condition in which the furnace bridgewall temperature is 1500 deg F and

Robert D. Reed, left, chief engineer, and John Zink, founder and president, of the John Zink Company, Tulsa, Oklahoma.





Meriam draft gager at Winnie, Texas, cycling plant of Glenn H. McCarthy, Inc., Houston, Texas.



Part of the 150 engineers who attended the Process Heating Seminar sponsored by John Zinc Company, Tulsa, Oklahoma, June 10, 1950. In the background the Information Panel is composed of J. B. Bellah, Refinery Engineering Company; J. L. Parker, The Girdler Corporation; Dr. Sidney Born, Born Engineering Company; Davis Read, Universal Oil Products Company; D. F. Gerstenberger, Alcorn Combustion Company; T. B. Leach, Petro-Chem Development Company; L. B. Sutherland, C. F. Braun Company; F. Duane Fuqua, Koch Engineering Company.

the temperature of the tube surface is 1000 deg F. The heat content of the flue gas exiting from the furnace in point of radiant availability would be 27,300 Btu per pound mol of fuel burned or 14.5 per cent of the total available radiant energy. Although the operator of a furnace is compelled to live with this condition because of the necessity for continuous and rapid purging of flue gas to make room for still more flue gas as produced by the burners the factor is due for consideration.

Other factors governing the rate of radiant absorption are well established laws pertaining to the fourth powers of the absolute temperature differentials and the variation in radiant transfer according to the distance between the radiant and the absorptive bodies with radiation varying inversely as the square of the distance.

It is of course true that in a furnace any particular radiant point is surrounded but it is not surrounded entirely by absorptive surfaces since a portion of its surroundings will be refractory that must absorb and reradiate the energy. Here we encounter another condition which is relative emissivity.

The flue gas loss plus the variables just outlined make it impossible for all the heat available by radiation to be absorbed by the transfer surfaces before the heat becomes unavailable due to passage from the radiant portion of the furnace. In most cases this figure will be approximately 20 per cent of the total but in some furnaces as observed this figure has calculated as high as 40 per cent. We find that there is not a true basis in fact for pure radiant transfer and begin to wonder just how it is that furnaces perform as they do.

We believe we have found the answer in the manner in which furnace gases circulate in the heater and the influence of furnace design on the manner in which the gases circulate. Common understanding as revealed in countless discussions with men who design and operate furnaces presumes that the gases resulting from combustion flow more or less directly if gently toward the point of exit from the furnace. In this course it is presumed that there is a progressive loss of heat so that the gases arrive at the bridgewall or point of exit at a temperature as indicated there. In point of fact it is to be agreed that the temperature indication at the bridgewell is correct but the means for reducing the temperature does not, according to the evidence we have gathered, lie in the gentle but direct flow toward the point at which the temperature is taken. The flow is not all direct as very large portions of the gases are detoured in their course by forces characteristic of furnaces and are caused to recirculate.

The discharge of gases away from the burners being at relatively high velocity sets up a low pressure area in the vicinity of the rapid motion in keeping with the well known Bernoulli effect to cause some recirculation and reheating of furnace gases. This is, of course, an important source of recirculation in the portion of the furnace near the burners but in point of heat usefully transferred there is a far more important source of recirculation.

The second source lies in a simple thermo-siphon action set up by the tubes themselves. This action exists because as hot gases from the open portion of the furnace come in contact with the tubes they lose a portion of their heat and become cooler. Having become cooler their weight per cubic foot is increased and they immediately begin to descend. In the case of wall tubes on a wall 11 ft 6 in. high we have observed descending velocities between the tubes and the wall of as much as 300 ft per min or 5 ft per sec. In the case of a vertical cylindrical furnace in which approximately 20 ft of the tubes were exposed to the open portion of the furnace we have observed descending velocities between the tubes and the wall of as much as 500 ft per min or 8.33 ft per sec.

In the case of the wall tube furnace the length of tube exposed to the open portion of the furnace was about 30 ft 0 in. and the clearance between the wall and the tube was approximately 0 ft 2 in. therefore there were approximately 5 sq ft between the tube and the wall through which gas was moving at 300 ft per min. The volume of gas thus moved would be 90,000 cu ft per hour per wall or 180,000 cu ft per hour for both walls. This is 25 times the volume of the furnace or if you choose the entire furnace volume of gas is recirculated by the tubes on the wall once every 2.4 min.

It follows of course that the volume of gas that is being recirculated from the open part of the furnace because to be elementary if gases are flowing downwardly between the tubes and the wall the supply for the flow must come from the open part of the furnace. Gases drawn from that part of the furnace are gases presumed to be flowing gently but directly toward the point of exit from the radiant part of the furnace.

It is also true that the greatest portion of the supply for recirculation is drawn from the area nearest to the tubes and that portions of the gases nearer to the center of the furnace are uninfluenced by the recirculation so some of the gas does go directly to the point of exit—but not all of it by any means.

Whether the heat absorbed by the transfer surfaces through this phenomenon of recirculation is to be considered as "convected" or "radiant" is unimportant in view of its obvious presence and service to the process. Any design that tends to hinder recirculation will cause inadequacies in service as has been shown in numerous

specific cases an example of which will be pointed out later.

At time, in floor-fired furnaces, the velocity of the descending column of gases is great enough to be seen blowing the flames on burners adjacent to the wall toward the center of the furnace because the column, striking the floor, flows out toward the center of the furnace.

A further source of benefit that may be directly attributed to recirculation is that the descending column heats the wall behind the tubes to cause the wall to radiate a far greater quantity of heat to the tube than would be the case if the recirculation should not be present and the wall was re-radiating only heat received from other parts of the furnace by radiation. The nitrogen and oxygen being in direct contact with the wall give up their heat very readily to the wall. This point will also be shown quite clearly in the recitation of an experience with a furnace in operation.

Having thus theorized it seems justification in clinical experience is indicated and we now offer two selected instances that seem very much in point.

In the first case a furnace had been in service for many years during the passage of which the wall behind the tubes had started to fail in such a manner that the clearance between the tubes and the wall through which circulation occurs had been increased from its original 2 to almost 6 in. Along with the increase in recirculation space there had been taken a very nice increase in capacity so that the heater was handling much more than it had been designed to handle.

The mechanical department of the plant in which the heater was in service noticing that the wall was about to collapse caused the heater to be shut down and set about restoring the walls to their original position. Having done so, it was deemed advisable by the group to further gannister the walls to such an extent that when the heater was pronounced ready to be returned to service the walls almost touched the back sides of the tubes.

When the heater went back on stream it was capable of handling only 60 per cent of the duty it formerly had handled. In the absence of a suggestion that the 40 per cent decrease in duty might be due to the fact that recirculation could no longer occur because the space behind the tubes had been closed it was presumed that the loss of duty was caused by lack of re-radiated heat from the wall.

In this case it was clearly demonstrated that lack of space between the tube and the wall caused a very drastic reduction in the rate with which the heater could absorb heat but the question as to whether the reduction was caused by lack of recirculation or lack of re-radiation was not resolved.

In another case that followed the instance just related there was a very clear cut demonstration of the part played by recirculation with no interference being made with re-radiation.

In this particular heater that was floor-fired, the operators observed the action of the descending column in blowing the flame away from the side-wall tubes. They theorized that by interfering with the descending column the flames would no longer be blown toward the center of the furnace and a greater quantity of heat would thus be available for the side-wall tubes to increase the through-put in the heater which is in all cases an admirable end result of experimentation.

The manner in which it was proposed to interfere with the descending column was unique in its certainty of interference with the descending column without in any way interfering with the delivery of radiant heat to the wall or with re-radiation from the wall to the tubes. The method used proposed the use of split brick set between the tube and the wall in such manner that the brick failed to touch the tube by about ¼-in. and with the brick set with its long axis parallel with the floor. As there were but 10 side-wall tubes on each wall, each tube had the space between it and the wall blocked.

When the heater was put on stream the operators were chagrined to find it capable of only about 80 per cent of its former duty despite the fact that the flame no longer blew toward the center of the furnace but instead stood straight up to show no influence from recirculation.

We, being observers, offered the suggestion that the idea of causing the flame to stand straight up possessed certain merit but that the means for causing the flame to so stand was probably in error because the recirculation was to all appearances completely stopped despite the fact that there was no interference with re-radiation from the wall.

The heater was shut down, the split bricks were removed and a wall 12½ in. high running the length of the furnace and almost tangent with the burner openings was substituted for the split brick back of the tubes on the theory that interference with the operation of the burners by the recirculated gases could be stopped by the wall without interfering with recirculation through and back of the tubes.

When the heater was again put on stream the operators found to their delight that the heater now handled approximately 20 per cent more oil than it had been able to process before the program of experimentation was started. The flames stood straight up to prove that the wall was serving its purpose.

We feel that this case clearly shows the importance of recirculation as distinguished from re-radiation. It is true that this is just a single case and there are many heaters but this is only one case of many in which we have applied the theory of recirculation in correcting heater deficiencies.

The improvement in capacity here was also partially due to improved distribution of heat at the arch of the furnace because the heat was no longer concentrated at the central portion of the arch. Allowing the flame to stand straight up accounted for the improved distribution at the arch. The significance of this experiment lies in its demonstration of the importance of recirculation in the furnace.

Modern surface design, which increasingly tends to relatively long and relatively narrow furnaces, whether the length be vertical or horizontal and whether the shape be rectangular or circular, unconsciously perhaps, follows the theory of recirculation. The smaller the open space within the furnace (within limits, of course), the more efficiently heat may be withdrawn from the open part of the furnace and less heat is lost in direct flow to the point of exit as discussed previously.

Because burners could not be had to make very short flame old furnaces that have provided clinical data for the construction of many later furnaces were made much too large as has been proved repeatedly in the fact that many furnaces of design current 15 years ago are now doing as much as 225 per cent of their design figure with complete satisfaction to the operators.

It has been our observation that a clearance of ½ tube-diameter between the tube and the wall is a minimum figure for satisfactory conditions of transfer and recirculation with more clearance being indicated if economics of construction will permit with particular reference to tube hanger cost.

This paper, written in all humbleness and respect for the men who have caused the process industries to come as far and as fast as they have, seeks to point out the source for the relatively minor "X" quantities, which for years have plagued the designers of furnaces to permit them to strike out on new and bolder paths to benefit themselves as well as the entire process industry. * * *

Metallurgy for High Temperature-High Sulfur Process Conditions

New Alloys Offer Better Results for Severe Operating Conditions According to This Study by the President of Fahralloy Company

F. M. FAHRENWALD†

WHAT I intend to do in this paper is to present a general summary of what high-temperature steels are, what they are used for, some of their properties, and how you can use them in your industry.

In general, we define our high-alloy steels as ferrous alloys containing over 14 per cent of chromium, with or without the addition of nickel, and used primarily for corrosion resistance or heat-resistance at temperatures of over 1000 deg F.

The story of these stainless steels hinges upon the discovery and development of their most important ingredient, chromium. Chromium was first discovered in 1796, by Vauquellan; and about 25 yr later, Stodart and Faraday, in a search for stainless steel, made alloys of approximately 1 to 3 per cent chromium. The improved hardness and corrosion resistance of this alloy was noted by several investigators, but through a series of peculiar circumstances, nothing fundamental was discovered in relation to stainless steels until after the turn of the Twentieth Century. In the case of Stodart and Faraday, in England, their misfortune lay in their choice of dilute sulfuric acid for testing the corrosion resistance of their new material. This particular combination of acid type and acid concentration, plus the low chromium content of their steel, led to a very rapid attack. Even in our modern stainless steels, with adequate chromium contents, this acid is a very potent corrosive agent. Yet another difficulty faced by the early experimenters was the fact that the ferrochrome they were using for the alloying of their steel was made by reducing chrome ores with carbon. This carbon combined with the chromium, and nullified the effect of the chromium.

As late as 1892, Hadfield, in England, making observations on alloys containing chromium as high as 17 per cent, reached the conclusion that chromium actually impaired the corrosion resistance of steel! Examination of his work reveals that his principal observations were made on alloys containing up to 9 per cent chromium, which falls just short of the stainless range. Those alloys with higher chromium, which he did observe, had correspondingly higher carbon content to cancel out the effects of the chromium. And to top it all, he unfortunately chose a 50 per cent sulfuric acid solution in which to test his samples — following an assumption, popular at that time, that the attack of this acid was representative of corrosion in general, and was an admirable one to use for an accelerated test.

By about 1900, a low-carbon ferrochrome had been made available, and Guillet made use of this to make his low-carbon alloys. Indeed, he made many steels that fall strictly within the range of the proprietary analyses of stainless steels used today. From his extensive investigations of the metallography, heat treatment and mechanical properties of these alloys, he can definitely be identified as the father of stainless steels.

One of the most brilliant investigations in the history of these steels must be credited to P. Monnartz, of Germany, who plotted the stainlessness of chromium steels as related to the chromium content, under the influence of some of the common corrosive agents. He identified passivity and made measurements of the electromotive forces. He demonstrated prepassivation. His work indicated the importance of carbon content on the corrosion resistance of the stainless steels; and he went on to discover that the addition of titanium, vanadium, and molybdenum can stabilize the carbides. These men, then, are the true originators of stainless steels.

The story of the later applications of these materials to industrial usage is complicated by extensive and bitter court litigations and patent fights, and true credit for many of the improvements made are forever lost in the maze of legal records. But the logical steps up the ladder to the austenitic 18-8 stainless steels, and the higher nickel contents characteristic of the heat-resistant grades known today, may be credited to the work of such men as Strauss, Maurer, Franks, Bain, Haynes, and Becket—for they are all high on the honor list.

It might be well to discuss here, briefly, some of the industries, other than your own, which are served by heat-resisting and stainless steel castings. I am a firm believer in the fact that in a great many cases, if you can see what the other fellow is doing, it might help you in your own problems — even though, on the surface, there appears to be no similarity between his industry and your own.

We design, engineer, and sell to just about every major industry that you can think of in this country; and it is a basic fact that if all production of high-alloy castings were to stop today, industry as we know it would become impossible. There is a constant trend towards higher process temperatures, more production, heavier loading, which means that we in the alloy industry must keep pace by developing better metals, better production techniques and, above all, better designs.

Let us consider, first, the high-temperature applications in industries that require materials exhibiting strength and oxidation resistance at elevated temperatures. Probably the biggest field is in the heat treatment of metals. Wherever maximum physical properties are to be obtained in finished metallic products, they are usually put through at least one, and sometimes as many as three or four heat-treating cycles: Annealing, normalizing, carburizing, or hardening operations. Particularly in high production industries, this means that complicated continuous or batch-type furnaces must be built in order to carry these parts through the particular heat-treating cycle. And for these operations we supply many tons of conveyor chains, protective muffles,

†President of the Fahralloy Company, Harvey, Illinois.

skid rails, conveyor trays, special fixtures, and retorts — as well as many miscellaneous furnace parts, such as carburizing boxes and pots for molten salts and lead. Such parts are supplied to furnace manufacturers, to commercial heat treaters, and to the production plants themselves—such as automobile plants, farm equipment manufacturers, aircraft factories; to producers of tools, springs, bolts, screws, forgings, and to makers of many other metal products too numerous to mention.

Another very important industry to us is the poreclain-enameling industry. They are the manufacturers who produce our stoves, refrigerators, enameled signs, sinks, bathtubs, etc. These products all consist of a base of steel or cast iron, which is then coated with a ceramic material. This coating is fused to the steel, and therefore some means must be devised for the handling of these various objects to be enameled through the high-temperature glazing operation. We have supplied many tons of supporting hooks, hangers, bucks and bars and such porcelain-enameling furnace parts. The temperatures involved in this industry average around 1600 F, and it is exceedingly important that the materials selected for these uses be highly oxidation resistant, and must be particularly resistant to spalling, or flaking off of the oxide coating that forms on all nickel-chromium alloys at elevated temperatures. When it is realized that an entire stove body, for instance, can be ruined by one small speck of oxide falling on the enameled surface, it can be seen that castings of the highest quality are of utmost importance in this industry.

The cement industry takes considerable tonnage of alloy castings—used here for kiln-end retaining rings, recuperator liner plates, burner nozzles, and for such applications where high temperatures and abrasive conditions are encountered. The kiln-end segments, for instance, form the rings at the ends of the kiln, which take the thrust of the firebrick lining upon expansion. When it is seen that these cast alloy components operate at red heat, and must withstand this terrific push, as well as to take the abrasive effect of the burned cement discharging over them, it can be seen that this industry has its high temperature problems, too.

We are also involved in the production and refining of metallic ores, particularly in the preliminary roasting stages where, in some cases, sulfide ores are roasted down to the oxide of the particular metal. This process is carried on in large rotary roasters, and we supply the so-called rabble blades and supporting arms that stir up and convey the material through these roasters. Temperatures here range from 1200-1800 F, and again the combination of high-temperature strength requirements and the corrosion of sulfur containing ores are encountered. The same type of roasters, incidently, are used in sugar refineries and in modern sewage disposal plants.

Probably next in importance to the heat-treating field, in terms of tonnage at least, is your own oil industry. Here we have many high temperature and corrosion-resisting problems, particularly since the trend in the last few years has been toward higher temperatures and pressures. The major items produced for your industry are tube sheets, tube supports, burner castings, bubble caps, cast return-bends, and many other special parts. To service this industry, we must supply castings that will stand high temperatures, corrosive liquids, and gases; and, the problem peculiar to your industry, is to supply alloys that will withstand the corrosive effects of high-temperature, high-sulfur bearing gases.

The above comprise the major heat-resisting applications of our products; but there are, of course, many smaller users of such castings, such as the paint, glass, and chemical industries.

As for the stainless steel end of our business (which, incidently comprises some 15 per cent of our total production) the major fields served by this type of casting are the food industry, where federal laws are requiring the use of all-stainless equipment in canning machinery and the like; the paper industry where our castings are used to withstand the corrosive sulfite liquors, and the chemical industry, which we supply with many stainless steel castings through the manufacturers of pumps, valves, fittings, meters, and the like; the oil refineries, where a number of valves, pumps and many other parts are now specified in stainless steel. And last but not least is the interesting case of the liquor industry. Here we have supplied pump castings of 80 per cent nickel, 13 per cent chromium, for the pumping of whiskey and gin. I understand that almost undetectable traces of impurities in such castings will cause discoloration of the distillers' products.

I believe that the foregoing is a pretty fair summary of the outstanding uses of corrosion and heat resisting castings, and I believe that you will agree with me that no one individual organization that serves so large a proportion of American industry, such as we do, can be expected to know all about any one of them. Consequently, as mentioned above, I will not attempt to go into specific applications in your field, because I am sure, gentlemen, that you know more about it than I do.

But I will go into a discussion of some of the properties of the metals that we manufacture, and that you use. The most common structural material now in use is, of course, ordinary low-carbon steel. Many millions of tons of this material are in use at the present time in the form of tanks, shells, structural beams, and the like, and in so many places that its use is more or less taken for granted. This material oxidizes relatively rapidly, even at ordinary temperatures and under ordinary conditions, and, of course, can be protected under these conditions by painting or other means of coating. However, as the conditions of its environment change, its properties also change. As temperatures rise, the oxidation rate increases and its structural strength decreases, until at temperatures of around 1000 F it becomes practically unusable. For example, at 1400 F, a .30 carbon steel will oxidize in air at the rate of nearly 1/16 in. per 100 hours. At the same time, its load carrying ability will decrease from a safe stress figure of say 25,000 or 30,000 psi at room temperature, to less than 500 psi at 1400 deg. So it becomes obvious that some other material must be used under such conditions.

It is known that the addition of chromium to steel will drastically reduce the oxidation rate and also will considerably improve its high-temperature load-carrying ability. Such additions, in excess of about 16 per cent chromium, render the steel almost completely immune to oxidation. Apparently what happens at the elevated temperatures in a high-chromium steel, is that the surface does oxidize, but this oxidation produces a thin, tightly adherent oxide film which resists further penetration of oxygen below the surface of the film. The increase in load-carrying ability is not enough, however, to permit low-chromium steel—say around 14-16 per cent, to successfully be used as a structural member at temperatures of anywhere over 1200 degrees F. Further additions of chromium, up to 28 per cent, do enhance the oxidation resistance and strength of these alloys, so that the straight 28 per cent chromium steel is a fairly common alloy; but it must be used where extreme load-carrying ability is not required.

It was further found that the addition of nickel to this series of iron-

chromium alloys enhanced the high temperature strength tremendously; and from this fact there has been developed a commercial series of alloys which will meet almost any industrial requirements; and one can obtain, within limits, almost any desired combination of load-carrying ability, oxidation resistance, or hot-gas corrosion resistance.

This term "oxidation resistance" refers, strictly speaking, to the resistance of a metal to an air or oxygen atmosphere at elevated temperatures. It must be realized that the term "corrosion resistance" is a relative term, and that small additions of certain elements to the environment can make a tremendous difference in the corrosion resistance of a particular alloy.

Perhaps a little closer definition of the terms "corrosion resistant" and "heat resistant" might be in order. Tungsten, for example, is a very, very superior "heat resisting" material in an atmosphere of nitrogen, argon, or perhaps in a vacuum. But tantalum, of about the same melting point, cannot be used in nitrogen, and neither of these elements is as heat resisting as ordinary cast iron, when in contact with hot sulfuric acid. And iron is a better material than platinum for lead-melting pots. Obvious examples such as these only illustrate the fact that as far as resistance to high temperature corrosion is concerned, a given metal or alloy is "best" with reference only to some certain set of conditions. Therefore, in the proper application of these heat resisting materials, it is of utmost importance that the designer know exactly what the operating conditions will be.

From the many hundreds, and perhaps thousands of variations in the possible combination of nickel, chromium and iron, a series of analyses has emerged as being the most practical for use in various commercial applications. These are as follows:

65 per cent nickel — 20 per cent chromium.

38 per cent nickel — 18 per cent chromium.

20 per cent nickel — 25 per cent chromium.

12 per cent nickel — 25 per cent chromium.

2 per cent nickel — 28 per cent chromium.

8 per cent nickel — 18 per cent chromium.

2 per cent nickel Max.—14 per cent chromium.

These analyses represent the midpoint of the allowable range, and it should be pointed out that these metals also contain smaller amounts of other elements—notably carbon (averaging about .40 per cent, silicon (about 1.75 per cent, and manganese (about 1.5 per cent). The balance of the alloy is, of course, iron.

The first two alloys listed, which are high-nickel, low-chromium types, find their largest usage in the heat treating and porcelain enameling fields. These two alloys possess the best resistance to thermal shock, and have excellent high-temperature strength and good oxidation resistance in sulfur-free atmosphere. As a matter of fact, the 38 per cent nickel-18 per cent chromium alloy is the strongest commercial alloy known today, for high temperature use. These two metals are used, therefore, in applications where cyclic heating and cooling are encountered. Unfortunately, these two metals are very rapidly attacked by hot gases having sulfur content in excess of about 1 per cent, particularly in a reducing atmosphere, and it is this fact that precludes their use in most refinery heating applications.

Continuing down the list, you will find that the next three listed are the most widely used alloys for resisting heat and corrosion in your industry, namely: The 25 per cent chromium—20 per cent nickel, the 25 per cent chromium—12 per cent nickel, and the 28 per cent chromium—2 per cent nickel alloys. These alloys are exceedingly resistant to corrosion at high temperatures because of their high chromium content, and I would like to go briefly into the metallurgy of these compositions.

The three major types of crystal structure of our alloys are austenite, ferrite, and martensite. These words may require definition. They actually are a carry-over of the names assigned to cerain atomic arrangements found in pure iron. Pure molten iron, when it solidifies, forms its atoms into a body-centered cubic structure known as delta-ferrite. At 2550 F, it rearranges itself into the face-centered cubic structure knonw as austenite; and at 1670 F, reverts to a crystal arrangement identical with the delta-ferrite—but now termed alpha ferrite. This ferritic structure is retained at room temperature in iron. Martensite is a result of impurities in alloying of iron, and is actually a distorted and highly stressed arrangement of atoms caught in the transition from austenite to ferrite. As alloying additions are made to pure iron, they tend to change the transition temperatures, so that in the high-alloy steels, austenite may be stable at room temperatures. All three of these structures are clearly revealed by microscope examination of etched samples.

Here, on page C-16, is a simplified phase diagram, or constitution diagram, showing the metallurgy of nickel-chromium alloys with varying amounts of nickel and chromium.

You will note that the ordinates along the left-hand side of this diagram do not represent percentage of nickel, but represent a so-called "nickel equivalent." In the same manner, the ordinates at the bottom do not represent chromium percentage, but the "chromium equivalent." It can be shown that each of the elements, nickel, manganese, and carbon, have a definite tendency to promote a certain percentage of austenite, and therefore the ordinates along the left side represent the austenite-forming tendency of nickel, manganese, and carbon, expressed as a "nickel equivalent." As you can see, this is calculated as per cent nickel, plus, .5 per cent manganese, plus 30 times the percentage of carbon. In the same manner, the elements that tend to promote ferrite formation are chromium, silicon, molybdenum, and columbium.

On this chart, it can be seen that an alloy, say of the 28 per cent chromium—2 per cent nickel, with normal amounts of the other elements, will be situated as shown on the chart, and will be predominately ferritic in structure.

In a similar manner, a normal 25-

Chemical Consultant Makes Lecture Tour Through Europe

Dr. R. S. Aries, professor of chemical engineering at the Polytechnical Institute of Brooklyn, spoke before the Chemical Exposition at Frankfort, Germany recently, the only American on the program. Earlier last month, he spoke on recent advancements in the chemical industry in this country before the Societe de Chimie Industrielle in Paris. While in Paris he addressed the French Institute of Petroleum, describing the process of manufacturing anti-freeze from petroleum.

Several foreign governments invited Dr. Aries, one of the country's foremost exponents of the economics of the chemical processing industry, for a lecture tour of Western Europe. He has been investigating and conferring on how American industrial know-how can be translated into assistance to Europe within the framework of the European Recovery Program.

12 alloy, with a composition of:

23.50 per cent Cr
14.00 per cent Ni
.30 per cent C
1.50 per cent Si
1.25 per cent Mn

may be situated at the point indicated as Type 2, and should be predominately austenitic in structure. You will note, however, that this composition is very close to the dividing line between 100 austenite, and a ferrite-containing alloy; and a slight change in composition is very apt to throw it to one side or the other of the line.

As an indication of the difference in structure of several different analyses of the 25-12 alloy—all within the commercial range of analyses—I have indicated other points corresponding to analyses as follows:

Per cent Cr	12.00	12.00
Per cent Ni	27.00	25.00
Per cent C	.20	.30
Per cent Min	1.75	1.50
Per cent Si	1.50	1.25

The composition of the 25-12 stainless steel in the as-cast condition, consists of austenite, some complex chromium-iron carbides, and a small percentage of ferrite if it is present. Both the room temperature physical properties and the high temperature physical properties are affected by the difference in structure caused by only slight variations in the chemistry.

You are probably familiar with the ASTM specification B-190-45-T, under which a considerable percentage of tube supports and the like are purchased. If you will recall, this specification lists two grades of the 25-12 alloy. Type 1 is the partially ferritic type, and because of the magnetic properties of ferrite, will show a magnetic permeability of from 1.05 to 1.70. Type 2 is a fully austenitic type, which should show a lower magnetic permeability of between 1.00 and 1.05. Permeabilities of above 1.70 probably would indicate too high a proportion of ferrite for the best high temperature properties. In general, Type 2, or the fully austenitic type, has higher high-temperature creep-stress values, but has lower ductilities than the Type 1.

A further indication of the difference between these two types of the 25-12 alloy can be obtained by making room temperature physical tests on test bars that have been "aged" for 24 hours at 1400 F. Under such heat treatment, there is a precipitation of some of the carbides that have been previously held in the austenitic phase, and a subsequent increase in room-temperature tensile strength, and a marked decrease in ductility. This test is of use particularly if the castings are to operate in service in temperatures of around 1400 F, and especially if these conditions are followed by lowering to room temperature and the castings subjected to any rough handling.

A formula has been proposed to indicate the structure of the 25-12 grade, within limits. In the following formula, by using the actual chemical analysis of the steel, a ratio "R" is obtained:

$$\frac{Cr - 16C + 3Si}{Ni + \frac{Mn\text{-}1}{3}} = R$$

If R is greater than 1.7, a partially ferritic structure is revealed. If R is less than 1.7, the alloy will be fully austenitic. We have run many hot tensile tests, and it is interesting to note that by plotting this ratio R against the hot tensile strength, and also against elongation, some pretty good curves can be drawn. It is possible to predict, with a fair degree of accuracy, both the hot and room-temperature physical properties after heat treatment of any given sample of 25-12 alloy, just from chemical analysis.

In general, we can summarize the above statements by saying that if you want an alloy that is as strong as possible at high temperature, but not necessarily with high ductility, then the Type 2 grade of 25-12 is what you should have. If you have an application where high ductility is an important consideration, however, then type 1 is indicated, but the long-time operating temperatures should not be in the critical embrittling range. Type 1 is often required where severe thermal shock is a factor.

Now turning to the 28 per cent chromium—2 per cent nickel steel. As stated before, this has a predominately ferritic structure, and therefore will be rather weak at high temperatures, but it does possess good corrosion resistance, oxidation resistance, and ductility at high temperatures. At room temperature, however, this metal is very brittle and subject to breakage under shock, and unfortunately, up to the present time, it has rather difficult casting characteristics — most important of which is the rather extremely large grain size.

I have here a sample of a casting that has been broken, and you will note the extremely large grain size sometimes encountered in castings of this composition. You will note that the casting fractures along cleavage planes of individual crystals, and some of these crystals extend nearly halfway through the metal section, making rapid crack propagation a simple matter.

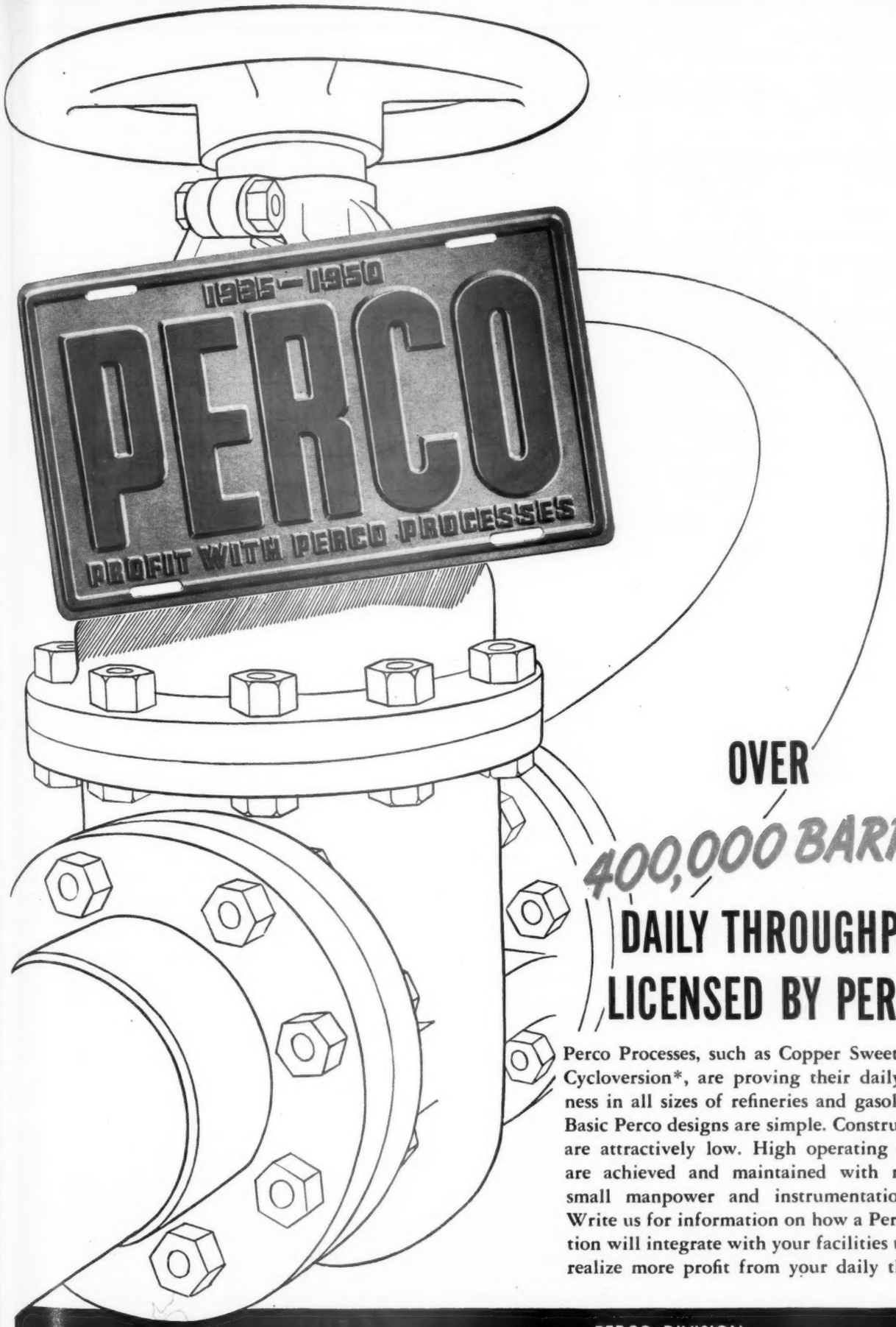
At the present time, we are running a research study on this problem, and believe that we have found a way to make castings of this analysis with small grain size; and also believe that such a decrease in grain size will show a corresponding improvement in ductility and room temperature impact strength. I have here with me several samples that show, at least in test runs, that the grain size of this alloy can be controlled. According to all the literature I have been able to read, the grain size of this alloy can be controlled by the addition of nitrogen. To date, we have been unable, in our foundry, to produce consistently fine-grained castings by the use of nitrogen. Nitrogen is usually added in the form of high-nitrogen ferro-chromium.

It might be of interest to you to examine the samples I have, which show a decrease in grain-size from the present practice, to a very fine grain obtained by the use of experimental furnace additions. I am sorry that our tests have not progressed to the point where I can reveal to you what the procedure is, but trust that in the next few months we will complete our tests to the point where we know we are right.

Nevertheless, even considering the casting difficulties and the room temperature brittleness of the 28 per cent chromium alloy, it is still an excellent alloy for parts that are not subjected to drastic handling or to drastic thermal shock. The many tons of burner castings produced in this analysis for the John Zink Company bear testimony to the fact that this is a very useful alloy and certainly has its place.

We hope that the tests we are now running will improve the properties to the point where it will become more universally used. The alloy is now being used extensively in ore-roasting processes, where the excellent resistance to sulfur corrosion at high temperatures is necessary. This very excellent resistance of 28-02 can be demonstrated by the fact that in the form of rabble arms and blades used in such roasters, many years of service are obtained in the roasting of zinc-sulfide ore—which involves temperatures of around 1400 F, and SO_2 concentrations of as high as 35 per cent to 40 per cent in the atmosphere surrounding the castings.

The next alloy I will discuss is the 18 per cent chromium, 8 per cent nickel alloy, which is commonly called 18-8 stainless steel. The composition of this steel is indicated on the constitutional diagram, and you will note that this also is very close to the borderline of the partially ferritic. Here again we have numerous applications



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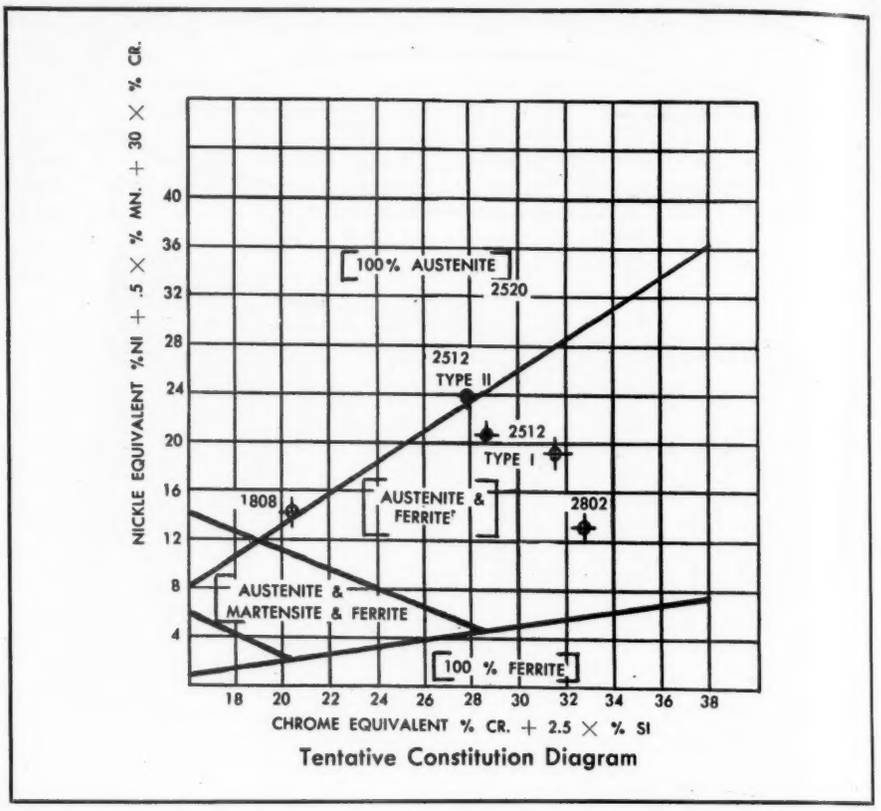
for corrosion resistance — pumps, valves, and the like, as mentioned previously—but this material actually is not, or should not be used too extensively for high temperature operations. This alloy can be employed up to as high as 1750 deg, but should be employed only for intermediate and particularly quite constant temperatures. As a matter of fact, the list of alloys presented earlier in this paper is arranged roughly in order of decreasing stability. Of course, you realize that no alloy in the commercial heat-resisting class possesses a chemical equilibrium that is perfectly stable against all temperature changes.

It is impossible to present in a paper of this length a complete discussion of all the factors that enter into the proper design and selection of heat-resisting alloys; but one important factor that I certainly wish more designers would pay attention to, is the fact that these alloys are produced in the form of castings, and as such they have certain limitations as to section thickness, complexity, and the like. We feel that all industries would be better served if more attention were given to designing for the foundry, as well as designing for the ultimate use.

Sharp corners, as well as small fillets and any abrupt change of metal section should be avoided, particularly since not only do these alloys have all the objectionable casting characteristics of other metals which are cast, but the alloys have most of the objectionable features to an extreme degree. The shrinkage upon solidification is greater than that of cast iron or cast steel. In general the pouring temperatures are higher — around 3000 F—and even at this temperature the alloys are quite sluggish, and the foundry practice throughout is considerably more difficult than in the more common cast metals. Ribbing should be eliminated wherever possible in your designs, because in addition to accentuating the warpage under changing temperature conditions, it presents the foundryman with the problem of feeding these areas. In a "T" section, for instance, unless the heavy area at the center of the "T" is provided with proper liquid feeding metal, a shrinkage area will develop in this place—which is not only a discontinuity in metal section, but also a chromium-deficient area, since the particular area involved will be the last to solidify. In very many cases where castings are improperly designed for the foundry, such areas will oxidize and "boil out" prematurely.

Another important factor in designing for these alloys, is to provide sufficient clearance for the expansion of the castings when in operation. The thermal expansion of the more common grades of heat resisting alloy is substantially greater than that of the usual structural materials, such as firebrick, and therefore upon heating up a furnace, the alloy members will expand to a greater degree than the other components of such a structure. At the same time, the thermal conductivity is much lower, so that if an alloy member is heated and cooled unevenly, two things happens: First, the dimensional differences (and the resulting stresses) are high; and second, the temperature differences are maintained longer and are more severe. If an attempt is made to bolt or weld heat resisting castings rigidly in place, warping, buckling, and cracking is almost sure to result. It is essential to keep these important factors in mind when designing high-alloy structures. I don't believe that in your industry the problem is too significant, as your operational temperatures are usually kept quite constant; but in other applications, such as furnace conveyer parts that are alternately heated and cooled, it is most important that consideration be given to the expansion and contraction when designing the installation.



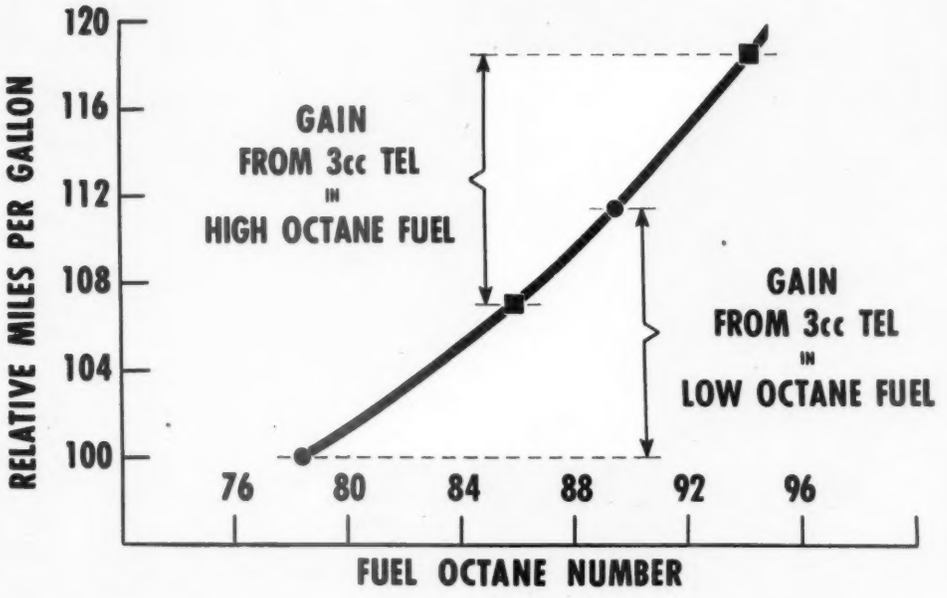
Tentative Constitution Diagram

Rather than try to introduce into this paper a number of charts and curves, I will refer you to the second page of our Design Data booklet, which shows the expansion characteristics, the oxidation resistance, and the allowable design strengths for the various grades of alloys. I believe that in your industry in particular, a great deal of money and casting weight could be saved by using these allowable stress figures, as, by proper design a beam of minimum weight can be obtained. In a great many cases, it seems to me, an inferior material, such as cast iron, has been replaced with high-alloy without proper regard for the working characteristics of the latter material.

I think it must also be stressed that creep values for a given alloy, which are secured under ideal laboratory conditions of constant temperatures and of simple continuous stresses, should not necessarily measure the ability of the same alloy to carry a load in operations involving time and temperature cycles.

There are a great many considerations that have to be given to the selection of the proper alloy for a given condition. In a good many cases, of course, it is almost impossible to accurately predict a reaction of a given alloy to a set of conditions. In such cases it is necessary to rely on past experience, and we feel that the alloy manufacturer who has, necessarily, a great backlog of such experience, can be of tremendous benefit to all industries in the proper selection and the proper application of these alloys to the particular problems at hand. * *

"Lead" adds as many miles-per-gallon at HIGH as at LOW octane levels



When measured by increased miles per gallon, tetraethyllead is just as effective blended in today's high octane base gasolines as in the lower octane gasolines of the past.

THERE has been a remarkable increase in the antiknock quality of base gasolines since "Ethyl" antiknock compound was first marketed in 1923. Despite this increase in the octane number of base gasolines, tetraethyllead is as effective as ever from the standpoint of the extra miles-per-gallon it can contribute.

The charts show data obtained in tests made at 6.1 and 8.5 compression ratios on an automobile equipped with an overhead valve engine, and with axle ratios selected to provide equal acceleration ability at low speed. Values of average fuel economy over the speed range between these compression ratios were computed by methods which check with experiment.

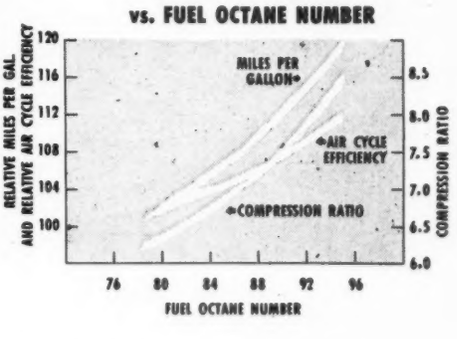
The chart below shows that permissible increase in compression ratio per octane unit becomes larger as the octane number of the fuel is raised, and shows that octane numbers at the higher levels are increasingly effective in the improvement of gasoline economy on the road.

From 6.1 to 8.5 compression ratio (corresponding to an increase in octane number from 78.3 to 95) the miles-per-gallon of fuel are boosted by approximately 19%. In contrast, the air cycle efficiency increases only about 11% over the same range of compression ratio.

In the chart above, the gasoline mileage curve of the lower chart is repeated. On the curve, the two circles show the improvement contributed by 3.0 cc tetraethyl lead when added to a base fuel of 78.3 octane number. The two squares show the gain from 3 cc tetraethyllead when added to a base fuel of 86 octane number. *The additional miles-per-gallon* are substantially the same.

Thus, when tetraethyllead is added to commercial fuels, it is just as effective for improving fuel economy on the road at today's high octane levels as at the lower octane levels of the past.

ENGINE PERFORMANCE vs. FUEL OCTANE NUMBER



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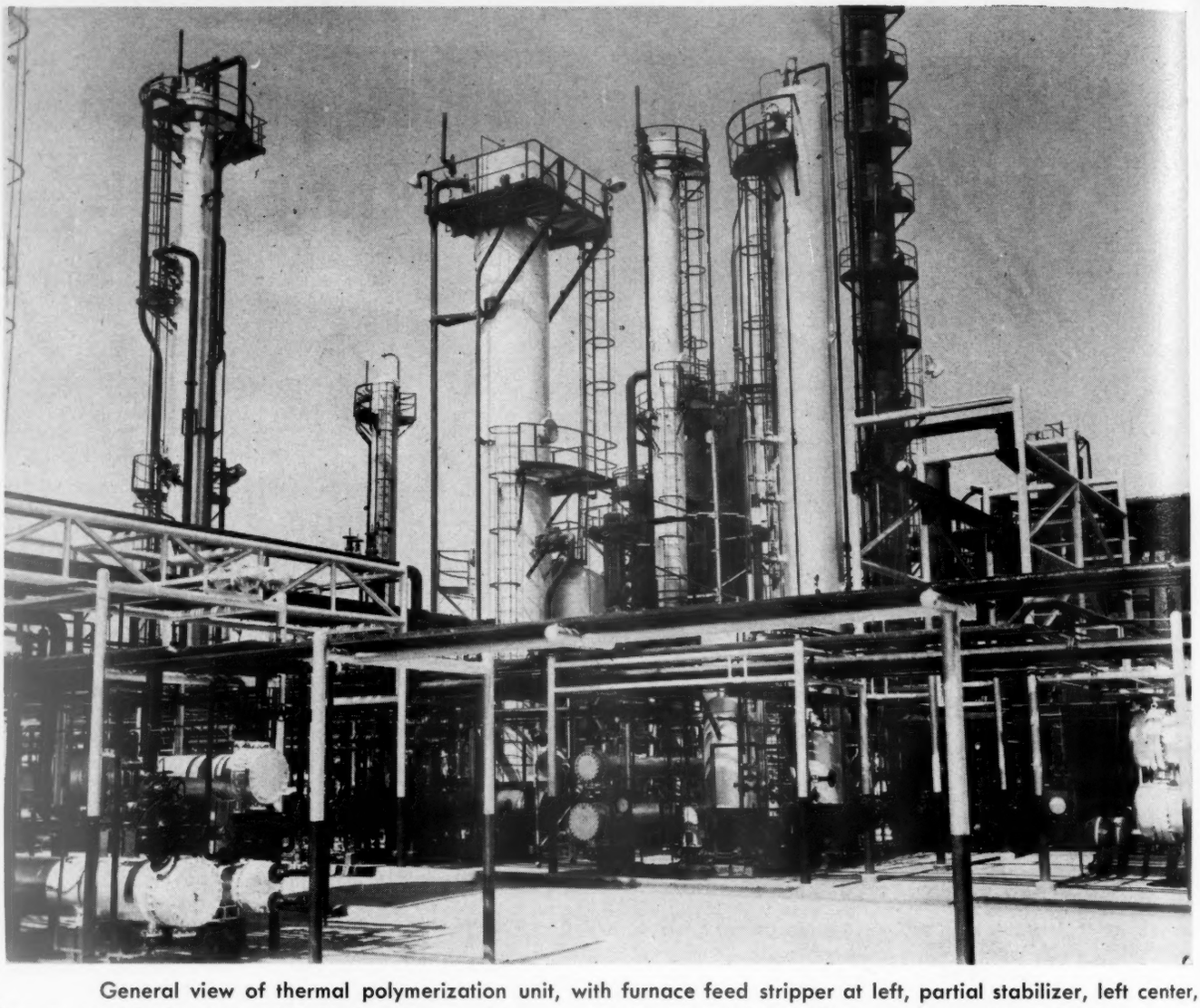


General view of thermal polymerization unit, with furnace feed stripper at left, partial stabilizer, left center, furnace at right background behind piping, and transeconomizers at right middle ground near foot of tallest tower.

Performance of Thermal Poly Transeconomizers

J. H. SMITH*

A thermal polymerization unit was installed at the Wichita Falls, Texas, refinery of Continental Oil Company by The M. W. Kellogg Company in 1940. This unit was designed to produce 440 bbl a day of 10 lb R.V.P. polymer gasoline from 1423 bbl a day of fresh feed with a coil feed rate of 8340 bbl a day, giving a combined feed ratio of 5.9. The design fresh feed composition was as follows:

Component	BPD	L.V.%
Methane	4	0.3
Ethane	69	4.8
Propylene	62	4.4
Propane	716	50.3
Butylene	108	7.6
Butanes	464	32.6
Total	1423	100.0

The feed consisted of light ends recovered from stabilization of pressure gasoline and raw casinghead. During the war the butylene, part of the propylene, and a corresponding volume of isobutane were used to produce aviation alkylate, thereby reducing the charge to the thermal poly unit. In 1946 a catalytic polymerization unit was installed for processing the propane-butane fraction recovered from thermal cracking and reforming. The effluent from the cat poly reactor is charged into the thermal poly unit for fractionation. In this way, the two polymer gasolines are yielded as a mixture, and the unconverted material from the cat poly

*Chief process engineer, Continental Oil Company.

The Author

J. H. Smith, a native of Hoagland, Indiana, received his elementary training there and his chemical engineering degree from Purdue University in 1940. After a period as process control engineer for another large oil company, Smith accepted a position with Continental as technologist in 1943. He was promoted to chief process engineer in 1948.

operation is recovered and processed in the thermal poly unit. In 1946 the volume of butane delivered to the refinery with the unstabilized casinghead stream was increased substantially. To offset this increase in butane feed to the thermal poly unit, the propane content of the field stream was reduced. Later, facilities were installed for producing LPG propane from the unstabilized casinghead, leaving the thermal poly fresh feed predominately butane with only a relatively small amount of propane entering with the cat poly effluent.

Referring to the simplified flow diagram, Fig. 1, the furnace feed pump takes suction from the furnace feed stripper through a suction cooler and discharges through the transeconomizers into the furnace coil. The charge is heated to about 1000 F at 1500 psig then held at this temperature for some time in convection section soaking tubes during which the cracking and polymerization reactions occur. After passing through the transeconomizers to preheat the charge, the furnace effluent flows through a pressure-reducing valve, thence through the partial stabilizer reboiler and a trim cooler into the partial stabilizer. The partial stabilizer bottoms are stabilized to the desired vapor pressure and rerun in equipment not shown on the flow diagram, and the light ends from the final stabilization operation are returned with the fresh feed. The overhead from the partial stabilizer passes to the furnace feed stripper where the recycle condensate is separated from the tail gas. In addition to the variations in fresh feed volume and composition described above, variations occur from seasonal changes in gasoline blending requirements and raw casinghead deliveries from the field. The rate of polymerization is varied according to the volume of fresh charge available by adjusting the furnace transfer temperature.

The transeconomizers consist of six 40-ft shells in series. Each shell is 4.4 in. ID and contains four 1½-in. OD, 8 BWG tubes. The furnace feed passes through the shells at an equivalent cold velocity of about 9.5 per sec. The furnace effluent passes through the tubes at an equivalent cold velocity of 18.2 ft per sec. The actual hot velocity of the furnace effluent entering the tubes is approximately 130 ft per sec.

The performance factors specified for the transeconomizers were:

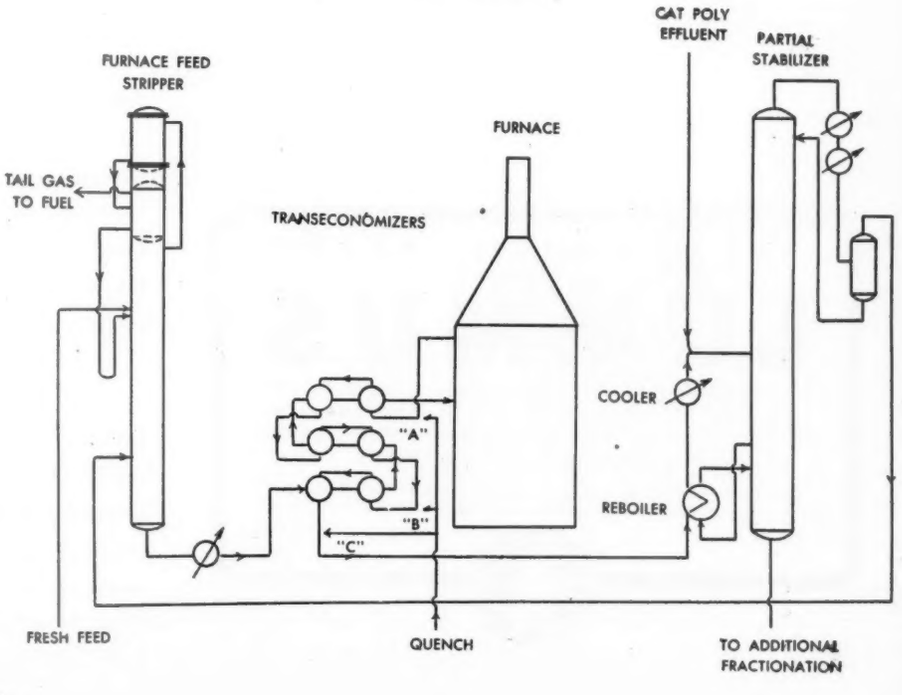
	Shell side	Tube side
	Furnace charge	Furnace effluent
Rate, lb per hr.	64,500	64,500
Molecular weight	47.6	46.0
Temperature in, °F	166	1,030
Temperature out, °F	650	570
Duty, Btu per hr.	23,500,000	
M.T.D., °F.	391	
Heat transfer coefficient.	160	

The actual performance of the transeconomizers varies with changes in volume and composition of the fresh feed. Any change that results in a greater concentration of heavy polymers in the furnace effluent increases the rate of coke deposition in the tubes resulting in an increase in pressure drop and a reduction in the heat transfer coefficient. An increase in fresh feed rate requires a higher conversion per pass thus increasing the rate of fouling. Similarly, an increase in the concentration of butane or olefins in the fresh feed results in more severe fouling because these materials polymerize more readily and with much higher yields than does propane.

The performance of the transeconomizers attracted no attention until the last year. They worked well, consistently giving better than design heat transfer. As a result, no records were kept from which to analyze performance for the various feed rates and compositions. However, the generalizations expressed above are clearly recalled. During the time that the alkylation unit was operating and the fresh feed to the thermal poly unit was predominately propane and contained little or no olefins, practically no fouling occurred, and the heat transfer coefficient must have remained well above 200, even after long periods of operation. The rate of fouling increased noticeably whenever the alkylation unit was shut down.

About 400 to 700 bbl a day of virgin naphtha has been mixed with the charge to the thermal poly unit since February 1949. This operation was begun cautiously, for we feared rapid fouling of the transeconomizers. Fouling has been worse than before but not as bad as we had expected. In an effort to counteract the fouling in anticipation of higher naphtha charge rates, we have tried quench injection at two points, "A" at the first pass inlet to the transeconomizers, and "B" at the inlet to the fifth pass. For quench we have used polymer rerun tower bottoms cooled and recycled at a rate of about 300 bbl a day. This material consists of heavy polymer gasoline, fuel oil, and some cycle gas

FIG. 1. FLOW DIAGRAM



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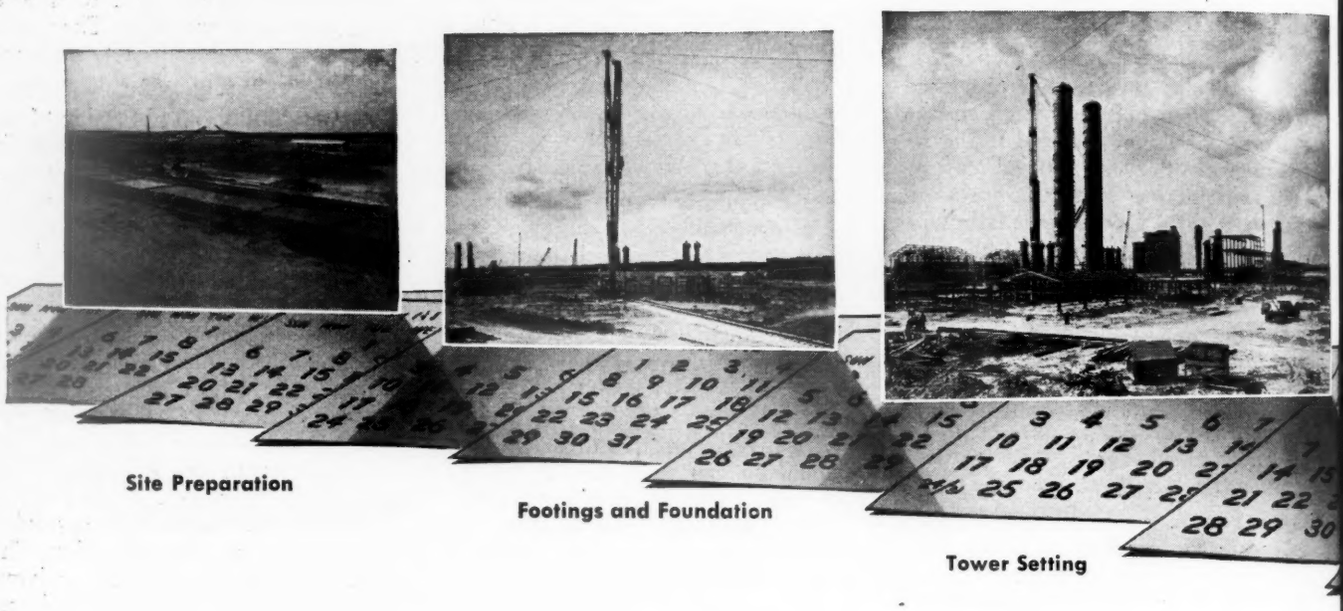

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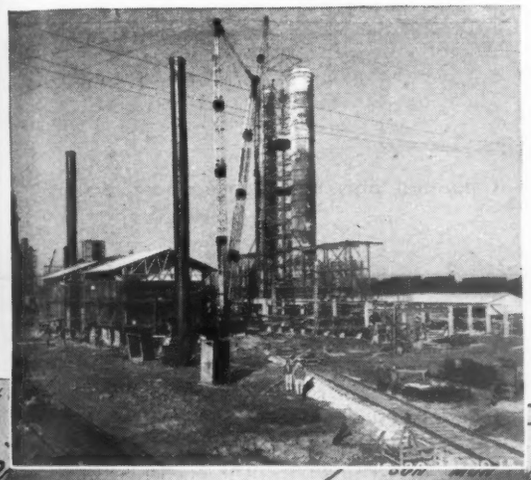
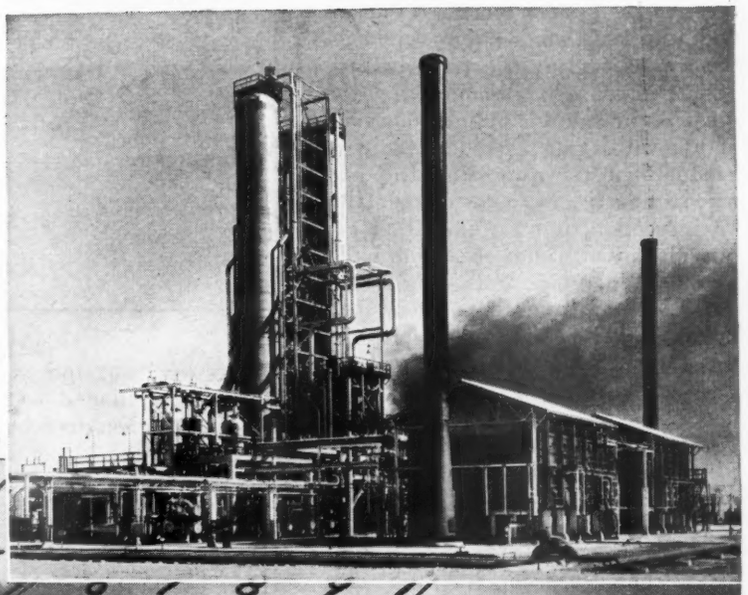


Tower Structure and Heater Erection



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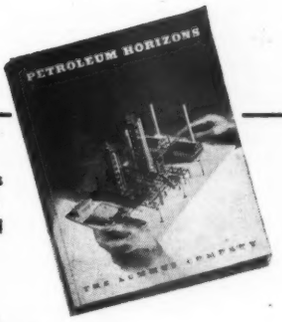

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oil from the thermal cracking unit that is injected into the fractionation system to retard reboiler fouling. The net make of rerun tower bottoms is charged to the thermal cracking unit evaporator for separation and recovery of the heavy gasoline fractions. It has the following properties:

Gravity, API	31
ASTM distillation	
10% @ °F	350
50	450
70	525
90	625

We first tried quenching at the transeconomizer inlet. Pressure drop through the system increased considerably in less than a day; so quenching was discontinued for the balance of the run. After discontinuing the quench, the rate of fouling continued at a normal rate as indicated by a gradual increase in pressure drop and a reduction in heat transfer rate. Upon inspection, it was found that the quench caused a knot of coke to build up on the inlet pipe wall a few inches down stream from the quench inlet point. No coking within the exchanger tubes was attributable to the quench. Past experience had shown that coke deposition was usually limited to the last two passes; so quench was injected into the inlet of the fifth pass for the next run. Results of quench injection at this point have been inconclusive. The quench appears to increase coke deposition from the point of injection to about 5 ft into the tubes of the fifth pass. From this point on through the system, coke deposition is less. The maintenance of high heat transfer rates seems to be improved by the use of quench, but the pressure drop increases at a higher rate when using quench. The use of quench definitely retards fouling of the partial stabilizer reboiler and the trim cooler; so quench point "C" was added at the outlet of the transeconomizers for use during test runs when quench was not added at point "B."

The coke is deposited uniformly as a thin scale in the tubes. It was observed on several occasions that the heat transfer improved after shutdowns, even when the transeconomizers were not opened and cleaned. This was attributed to the sloughing off of coke when the tubes cooled. The operators have taken advantage of this principle by reducing the furnace transfer temperature or changing the point of quench injection for short periods. The first attempt generally results in considerable improvement with each subsequent attempt resulting in less gain.

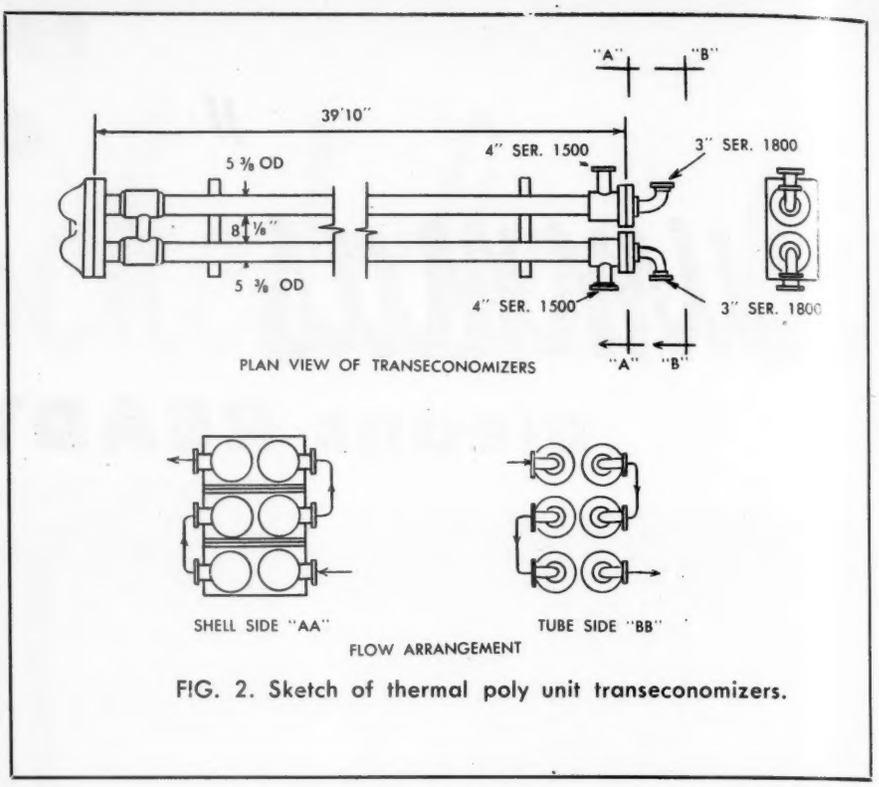


FIG. 2. Sketch of thermal poly unit transeconomizers.

Conditions at the start and end of two runs are shown in Table 1, one run with and one without naphtha. Typical compositions of furnace charge are shown in Table 2. A simplified sketch of the transeconomizers is shown in Fig. 2, and heat transfer coefficients versus time are plotted in Fig. 3 and 4. You will note from the irregularity of these plots that the self cleaning appears to happen frequently during operation.

Heat Transfer in Transeconomizer

Fig. 3 is a day by day plot of the heat transfer coefficient obtained when the unit was operating on a feed consisting essentially of butane. Following is a summary of the run:

23rd day: The heat transfer coefficient fell off from a value near 240 at the start to about 220 by the 23rd day. At this point the coefficient leveled off for four or five days and then began to drop more rapidly than before. Due to lack of operating data, the cause for this leveling off is unexplained.

38th day: The unit was shut down for emergency repairs. The heat transfer coefficient fell off to about 203.

41st day: The unit was started up. No mechanical cleaning of the exchangers was performed during the shut down, however, note that the heat transfer coefficient rose to about 225 immediately after start up. This reflects the self cleaning of the exchangers during the cooling off and starting up periods. The changing flows and temperatures probably caused coke particles to dislodge from the tube

TABLE 1. Operating conditions.

Feed: Propane-Butane (Run 12-9-48 — 1-28-49)	Temperatures – °F Furnace feed		Furnace effluent		Pressures PSI		Flows – bbl per day		
	To econ.	From econ.	Furn. trans.	Econ. out	Furn. out	Econ. out	Furn. charge	Quench	Naphtha to feed
Beginning of run	110	655	993	411	1525	1040	8800	None	None
End of run*	110	650	1002	415	1500	960	7800	None	None
Feed: Propane-Butane plus Naphtha (Run 7-1-49 — 9-18-49)									
Beginning of run	115	629	991	420	1550	1080	9000	450	500
End of run	115	597	979	436	1600	640	7000	500	500

* Data given are for 1-28-49 just before naphtha was added to feed. Actual run continued until 3-6-49.

TABLE 2. Composition of furnace charge.

	Propane-butane feed	Propane-butane plus naphtha feed
Date	3-29-49	11-2-49
	L.V.%	L.V.%
C_1	2.4	1.5
C_2	1.0	0.9
C_2	10.0	10.9
C_3	5.9	4.9
C_3	23.0	27.4
C_4	3.6	3.8
iC_4	22.8	11.6
nC_4	31.3	29.4
C_{5+}	0.0	9.6
	100.0	100.0

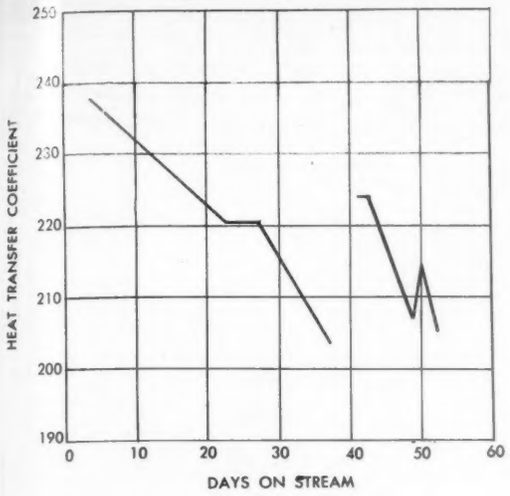


FIG. 3. Effect of coking on heat transfer in thermal poly transeconomizers with butane charge.

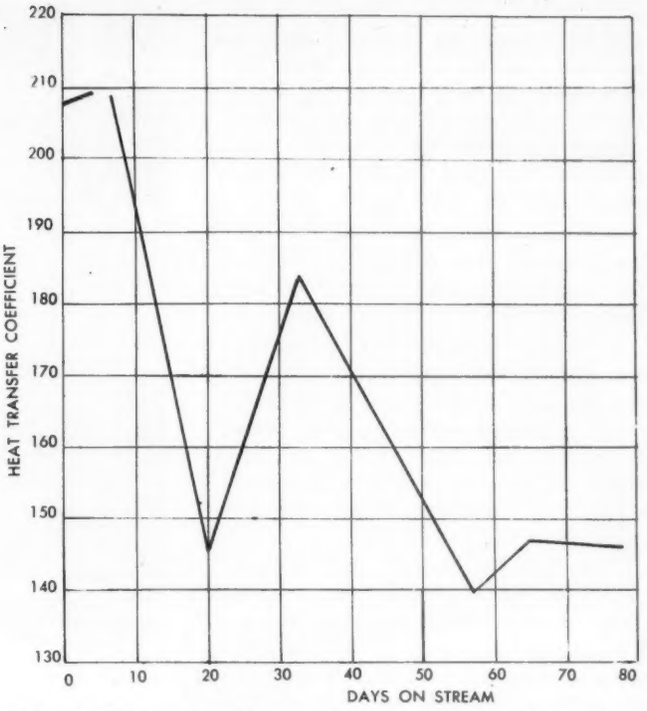


FIG. 4. Effect of coking on heat transfer in thermal poly transeconomizer with reforming naphtha charge.

wall. After operations were lined out, the coefficient declined at a much higher rate than before. Irregular coke particles adhering to the tube wall after startup apparently accelerated coking of the exchangers.

49th day: Reforming naphtha was injected into the fresh feed at the rate of 475 bbl per day. Prior to charging the naphtha, the heat transfer coefficient had fallen to about 207. The inclusion of the comparatively heavy naphtha in the feed resulted in some cleaning of the economizers and the coefficient rose to about 215 after about two days and then began to fall rapidly.

The unit was shut down after a run of 87 days on account of a high pressure drop across the partial stabilizer reboiler and loss in heat transfer in the transeconomizers.

Fig. 4 is a plot similar to that of Fig. 3 except that it covers a run when reforming naphtha was included in the feed.

A summary of conditions affecting the heat transfer coefficient is as follows:

The unit was started up on July 1, 1949. Note that during this run approximately 500 bbl per day of quench was injected into the inlet of the fifth economizer pass.

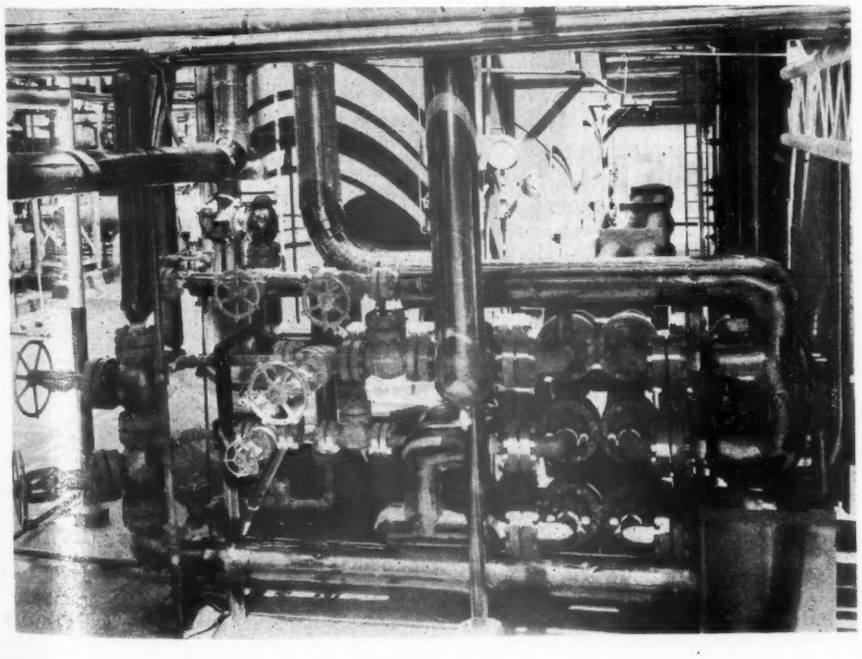
5th day: Shut down for 31 hours on account of a loose header plug on the furnace.

17th day: Washed economizers by injecting light cycle stock into the inlet to the economizers. Due to high pressure at the inlet very little quench stock was injected and the washing was ineffective.

19th day: Lowered transfer temperature five degrees to 982 F. Transfer temperatures were maintained in the temperature range 979-983 throughout the remainder of the run.

21st day: Charge rate was lowered because of the increasing pressure drop through the transeconomizers. At the same time, heat transfer in the transeconomizers began to improve rapidly; and on the 28th day the charge rate was increased 500 bbl per day to the former charge rate of 8700 bbl per day. The improvement in heat transfer continued until the 32nd day.

Front end view showing six economizer passes, furnace at right; vertical line, center, is transfer line from furnace; line passing horizontally above economizer is transeconomizer outlet to the furnace.

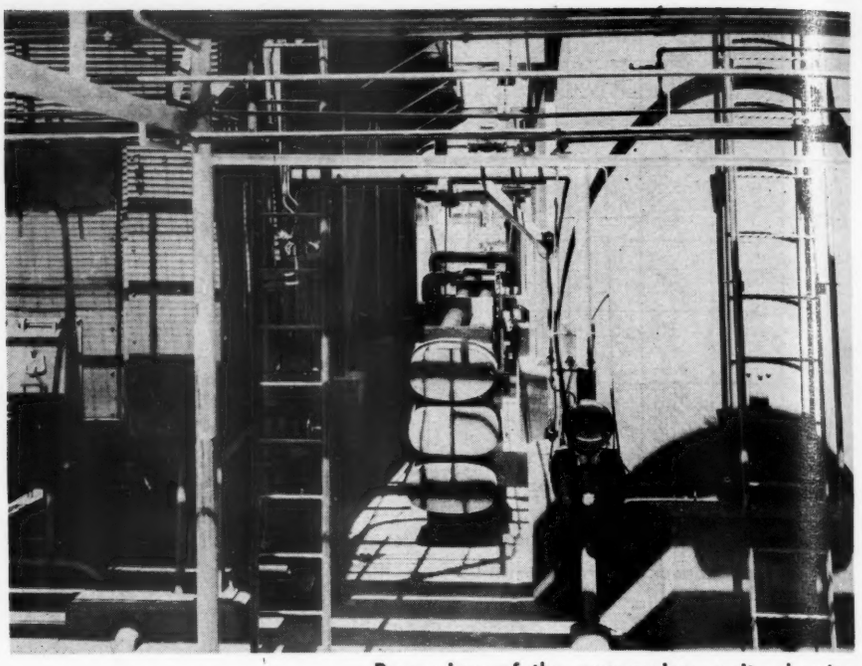


32nd day: The combination unit was shut down for cleanout, and the naphtha charge and quench were discontinued. Quench was started again on the 34th day, and naphtha charge on the 35th. The heat transfer rate, however, dropped steadily until approximately the 57th day.

53rd day: Because of the increasing pressure drop across the economizers, the charge rate was lowered 500 bbl per day to 8200 bbl per day.

55th day: Because of the poor heat transfer being obtained, an attempt was made to clean the transeconomizers by cutting out the quench for a few hours. Very little benefit was obtained. The heat transfer increased slightly for a few days then leveled off until the end of the run.

79th day: The thermal poly unit was shut down because of a high pressure drop across the transeconomizers. Upon inspection, a ¼-in. to ⅜-in. deposit of coke was found at the inlet to the fifth economizer pass. The coke was localized in two cells immediately downstream from the point where the quench was introduced 4 or 5 ft in the four 1-in. tubes of the fifth economizer pass.



Rear view of the economizer units showing their general construction with the furnace at left.

Conclusions

As a general rule, coking in process heating and cooling equipment is most severe at that point in the system at which the transition from vapor to liquid just commences or where the reverse transition nears completion, provided that the temperature at such point is sufficiently high to cause thermal decomposition of the liquid portion of the process stream. High boiling condensation products of thermal cracking and polymerization are especially unstable so that coking may occur at relatively low temperatures as in the case just described in which coking occurs in the temperature range of 600 to 400 F. Of course, for appreciable coking to occur at such low temperatures, it is necessary that the liquid undergoing coking reactions be maintained at this temperature for a prolonged period, which is the condition that prevails when the concentration of liquid in the flowing stream is too low to result in effective washing of the tubes. In a heating or cooling cycle during which a transition point occurs that might cause severe coking, the transition is sometimes made instantaneous to minimize or avoid coking. For example, in heating and vaporizing a heavy gas oil, steam may be injected into the stream at that point where vaporization approaches completion to cause flash vaporization of the residual liquid. Similarly, in a cooling cycle, quench may be injected at some point above which condensation commences and in sufficient quantity to immediately give an appreciable concentration of liquid phase in the stream. Actually, we expected rapid coking at the quench point as did occur because of localized sub-cooling when a small amount of quench was injected at the inlet to the transeconomizers. The test was easy and cheap to make and could do no harm if stopped in time; so we tried it on the off chance that it might improve operation.

The usual design for thermal polymerization units charging light hydrocarbons such as propane and butane specifies the use of tubular transeconomizers for heat exchange between furnace feed and effluent streams. In designing naphtha reversion or polyform units for inclusion of high concentrations of naphtha or gas oil in the furnace charge, a tar knockout drum and circulating quench system is usually specified. In this case, the tar is cooled by exchange with the furnace feed or other process streams and recycled to the furnace effluent line at sufficient rate to cause instantaneous formation of a high liquid concentration in the effluent stream. Obviously, the transeconomizer system is the simpler in design and lower in construction and operating costs, so that it is preferred when severe coking conditions are not expected. In addition, the transeconomizer makes possible waste heat recovery at a higher temperature level. You will note that we heat the furnace feed to 650 F in the transeconomizers at Wichita Falls, and, if desirable, this temperature could be increased by increasing the heat exchange surface. In the tar quench type operation, the temperature after quench is generally below 650 F so that waste heat cannot be economically recovered above 600 F and generally considerably lower.

It is not known why small changes in coil feed rate caused apparent self cleaning of the transeconomizers as was indicated at Wichita Falls. It is suggested that flexing of the tubes may have resulted from localized changes in temperature or pressure. As indicated in the examples, the improvements from self-cleaning were usually short-lived and of decreasing magnitude at each subsequent occurrence.

☆ ☆ ☆

A process to salvage valuable oil and wax from the settlings, or waste material, in the bottom of petroleum storage pits and tanks has been developed by the Bureau of Mines, in cooperation with several oil companies. A test with 2000 bbl of waste stored for several years in an open pit, recovered nearly 600 bbl of clean oil containing 15-18 per cent of valuable microcrystalline wax.

Acknowledgment

I wish to acknowledge the assistance of other members of Continental Oil Company in the preparation of this paper, with special acknowledgment to J. P. Markey and H. O. Meeks for assembly of the data presented.

* * *

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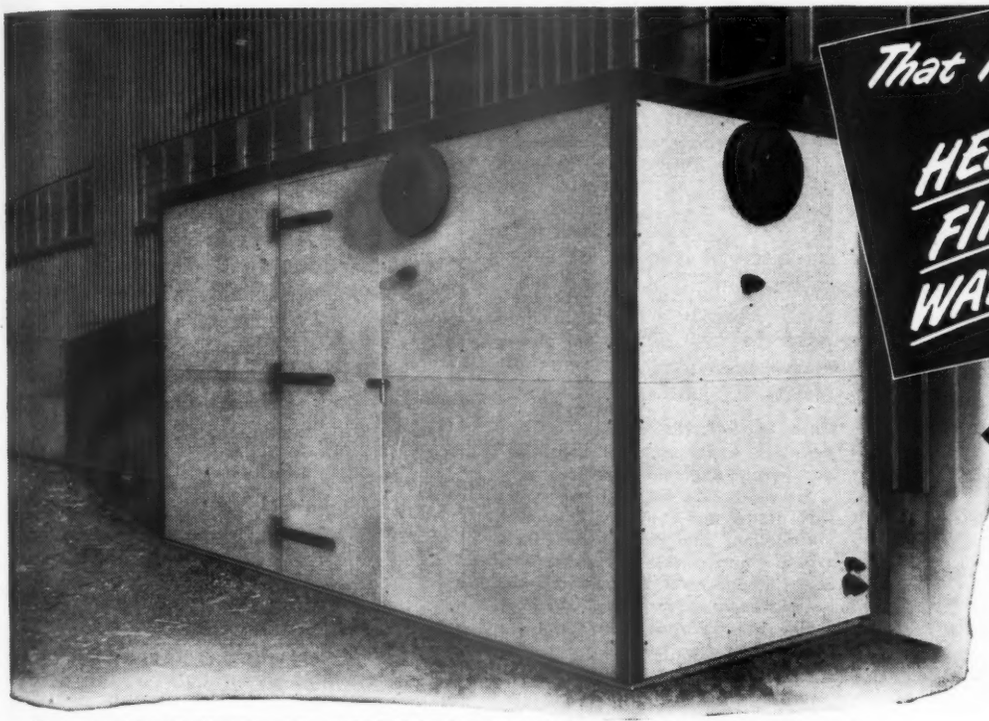

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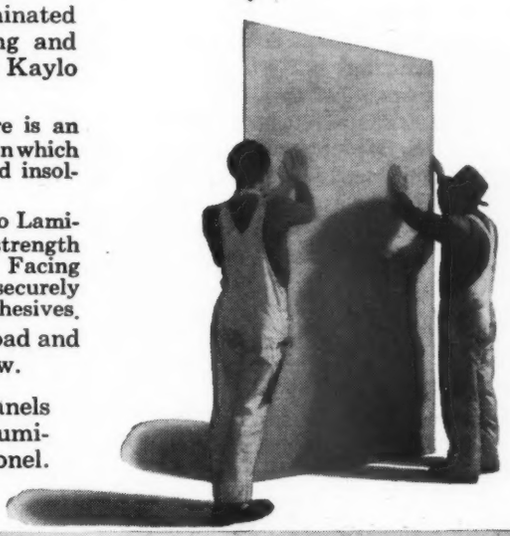

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Economics of Waste Heat Recovery

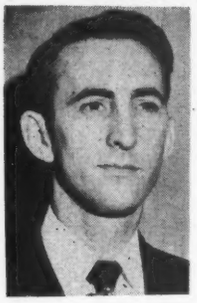
L. D. STEWART

WASTE heat recovery, by definition, is self-explanatory in that it is the utilization of heat that would otherwise be wasted. A prevalent, but out-dated notion is that the refinery power-process balance is of a secondary consideration and that a full-scale study is not often justified in an already designed and operating refinery. Such an attitude will undoubtedly reflect in higher production costs.

A simple list of methods of recovering waste heat, whether it be in initial design or in proposed operation changes, might be as follows:

1. Use low pressure steam for heating or process where possible, in existing equipment.
2. Increase the operating efficiency of furnaces and heaters by keeping the excess air to an operating minimum.
3. Install economical heat exchange to save cooling water and fuel:
   (a) Between oil streams.
   (b) With waste heat boilers, utilizing hot oil or flue gases.
4. Utilize exhaust steam, with the addition of new equipment, as:
   (a) Superheat, and use for process as in oil strippers.
   (b) Use for power drivers, as in low-pressure turbines.
   (c) Use for refrigeration, in either of three methods.
   (d) Heat boiler feed-water, as with steam exhausting from pumps, non-condensing, or even low pressure turbines.
   (e) Condense the exhaust steam and return to condensate.
5. Re-route water streams:
   (a) Use cold boiler feed-water in plant condensers and coolers, where practical.
   (b) Route semi-heated cooling water from one unit effluent to another unit, before returning it to the cooling tower.
6. Miscellaneous and future developments:
   (a) Determine the economical relation between the amount of steam and vacuum to use in a vacuum unit.
   (b) Establish optimum thickness of insulation.
   (c) Install properly designed steam traps on steam heaters, which will discharge only steam-free condensate.
   (d) Develop centrifugal compressors to economically handle vapor at high discharge pressures, to avoid condensing and liquid pumping when transferring to another heated process.

The Author



After being affiliated with the British American Oil Company, in Canada, for 6 yr as chemist, L. D. Stewart obtained an MA degree in petroleum refinery engineering at the University of Tulsa, in 1947. His research work on petroleum waxes was published in *Industrial and Engineering Chemistry*.

Since that time he has been on the staff of the Mid-Continent Petroleum Corporation, and now heads their process engineering department. Some of Stewart's "spare time" has been taken up in teaching night school in the University of Tulsa's refinery engineering department.

Items 1 through 5 will warrant further discussion.

Item 1—Use of low pressure steam. An operator will often use high pressure steam merely because it is convenient, where exhaust steam would suffice. A careful inspection throughout the refinery may reveal that high pressure steam is often being used on steam heaters in tanks and processing where it is unnecessary.

Item 2—Increased Furnace Efficiency. This operation requires no appreciable equipment investment. A few draft gages, a well-equipped Orsat and the formula:

$$\text{Per cent Excess Air} = \frac{O_2}{\frac{(21\ N_2) - O_2}{79}} \times 1000,$$

will determine the furnace efficiency, and possible saving in fuel gas.

Example: A 50,000,000 Btu per hr duty furnace, having a stack temperature of 750 F is operating at 70 per cent efficiency with 75 per cent excess air. If the excess air is reduced to 32 per cent, the calculated efficiency will be increased to 75 per cent (by use of John Zink Combustion Chart, or Nelson, Petroleum Refinery Engineer, 3rd Edition, page 367).

$$\text{Saving in Btu's liberated} = \frac{50{,}000{,}000}{.70} - \frac{50{,}000{,}000}{.75}$$

$$= 4{,}762{,}000 \text{ Btu's per hr.}$$

$$\text{Value of 1200 Btu per cu ft fuel gas, at 10¢/Mcf} = \frac{4{,}762{,}000 \times 24 \times \$.1000}{1200 \times 1000}$$

$$= \$9.52 \text{ per day}$$

$$= \$3332.00 \text{ per year per 50 MM Furnace.}$$

An increase over this saving can be attained on the furnace if proper burner and draft adjustments are made.

Item 3(a)—Heat exchange between oil streams. The net saving obtained by the recovery of waste heat is the value of the heat saved, less the cost of the equipment and the cost of operating. This net saving approaches a high limit for a given set of conditions, but decreases if any of the conditions are appreciably altered. It is therefore important to predict the best average operating conditions for economical design purposes.

An important element in the design of heat exchangers is the selection of the most economical "approach", or difference in temperature between the incoming cooling material and the outgoing heating material. This selection determines the surface versus the heat exchanged.

In general, heat is more valuable in proportion to surface, depending upon the payout time desired, but if a very low mean temperature difference is attained the cost of exchanger surface will soon offset this saving. In the basic exchanger equation:

Surface, sq ft =

$$\frac{\text{Btu's exchanged}}{\text{MTD} \times \text{transfer rate}},$$

the mean temperature difference and the overall heat transfer rate are both to the first power, so that lowering the mean temperature difference unduly, is exactly equivalent to having a low transfer rate, and the increase in surface requirements is proportional. This condition can easily get out of bounds in such units as solvent treating or dewaxing, where temperature levels are low but the heat to be transferred is great.

Finally, it is important to examine the overall heat balance of the unit being studied, as well as the component parts. For example, if the oil entering the convection section of a pipestill has been heated by exchange to something over, say 400 F, the flue gas temperature may be correspondingly increased to the extent that the saving in cooling surface and cooling water is more than lost in stack heat. The most economical heat-exchange may be determined by comparing the *total* cost of absorbing heat in the heaters and exchangers and removing it in the coolers.

*Example of profit from heat exchange:

Exchanger duty
= 6,400,000 Btu per hr

Mean temp. diff.
= 92

Overall transfer rate
= 35

Exchange Surface, sq ft

$$= \frac{6{,}400{,}000}{92 \times 35} = 1990.$$

30 deg rise cooling water circulation saved, at $.0060/M gal

$$= \frac{6{,}400{,}000 \times 24 \times \$.0060}{30 \times 8.328 \times 1000}$$

= $3.70 per day.

3% make-up water saved at $.1168/M gal

$$= \frac{18{,}432 \times \$.1168}{1000}$$

= $2.15 per day

1200 Btu per cu ft fuel gas saved, at $.1000/Mcf, and 75 per cent furnace effieciency

$$= \frac{6{,}400{,}000 \times 24 \times \$.1000}{.75 \times 1200 \times 1000}$$

= $17.05 per day

Total saving
= $22.90 per day.

Cost of installed exchange, using finned tubes, @ $275.00
= 275 × 20 = $5500.00
PAYOUT TIME
= 5500/22.90 = 240 days.

Item 3(b) — Waste heat boilers. Waste heat steam boilers utilizing hot oil streams, slurries or flue gases are now conventional equipment rather than the novelty of a few years ago. Typical examples include:

—Flue gas coolers on catalytic cracking units.

—Catalyst slurry coolers on catalytic cracking fractionating towers.

—Waste heat boilers using hot residual material from cracking.

—Waste heat boilers using tube still flue gases. The tubes for this operating 30 per cent of the total vection section of the furnace, or, by the use of induced draft circulation, in the breeching or adjacent to it. Hicks[1] gives a good description of these operations. One refiner in Oklahoma[2] is generating 30 per cent of the total steam requirement in this way. It is preferable to produce the steam with some superheat (as by using finned tubes) so that it can be used directly. This affords better efficiency on turbines and results in less line loss than with saturated steam.

The quantities of 140 psia steam, generated in fluid catalytic cracking units of various capacities, is somewhat as indicated in Table 1. The values are naturally very approximate, and vary with the carbon residue of the feed stock, conversion in the reactor, recycle ratio and other factors such as the original exchanger surface design. The steam generated may be increased by about 25 per cent if catalyst recycle coolers are used.

TABLE 1. Steam generation in fluid catalytic cracking units.

Oil charge to cat cracker, bbl per day	Heat exchanged in waste heat boilers, Btu's per hr	Lb per hr 98 per cent steam, 140 psia, from 300 F feedwater
12,000	47,081,000	52,000
15,000	67,000,000	74,000
18,000	84,200,000	93,000
21,000	95,972,000	106,000

It may be argued that the equipment for generating the above steam is part of the process equipment, and would have been necessary for cooling streams whether steam was generated or not. On this basis it is incorrect to establish a utility savings and determine a payout on the separate parts, as the equipment payout would be included in the entire unit payout. The calculated saving is therefore realized strictly by comparison of the method of cooling, i.e., by water cooling or steam generation, assuming that the cooling could be done practically in either way and that the surface cost would be nearly identical in either case.

Example: Using the 15,000 bbl per day charge in Table 1, the total heat in question is 67,000,000 Btu 1 hr, generating 74,000 lb per hr steam.* If this heat were removed by cooling water, the cost would be:

30 deg rise cooling water circulation cost at $.0060/M gal

$$= \frac{67{,}000{,}000 \times 24 \times \$.006}{30 \times 8.328 \times 1000}$$

= $38.80 per day.

3 per cent make-up water cost at $.1168/M gal

$$= \frac{192{,}974 \times \$.1168}{1000}$$

= $22.54 per day.

Total cost of cooling with water
= $61.34 per day.

If the heat were removed by generating steam, the cost would be:

Cost of treated boiler feedwater at $.1900/M gal

$$= \frac{74{,}000 \times 24 \times \$.1900}{8.328 \times 1000}$$

= $40.00 per day

Cost of fuel gas for 100 deg of superheating at 136 psia considered as integral with the generation of steam

$$= \frac{74{,}000 \times 74 \text{ Btu per lb} \times 24 \times \$.1000}{.65 \times 1200 \times 1000}$$

= $16.85 per day.

Total cost of cooling by steam generation
= $59.35 per day.

Therefore the cost of removing the heat from the process streams is practically identical whichever method is considered. In using the steam generation route, however, 74,000 lb per hour of steam is produced for necessary use by the cracking unit at a cost of only $59.35 per day. If this steam were taken from the power plant, the cost would be:

Power plant steam at $.2000/M lb

$$= \frac{74{,}000 \times 24 \times \$.2000}{1000}$$

= $355.20 per day.

This high value is of course due to the cost of heat and its diversion into

*Operating and depreciation costs omitted, but these are offset by the increased savings derived from the release of the cooling tower to other duty, or in obtaining cooler water.

*Boiler blow-down should be considered for greater accuracy.

steam. In the waste heat boilers the heat was "free", and this, then, is the substance of waste heat recovery.

Item 4(a)—Superheating exhaust steam. Several refinery processes require the use of stripping steam, the physical action being that of partial pressure reduction by having sufficient mols of steam present. No heating requirement is expected, although the steam should be sufficiently superheated to prevent self-condensation before reaching the over-head condenser. Under these conditions, and as the steam usually ends up in the sewer line rather than the condensate return, low pressure exhaust steam should be used for all stripping where possible, rather than the more expensive high pressure steam. The exhaust steam may be superheated in a direct fired heater, or where small quantities are involved, it may be superheated with live steam in a shell and tube exchanger.

Example: 100 mols of stripping steam per hour is required at 5.5 lb abs and 368 F. This is to be obtained by superheating exhaust steam from 250 F and 30 psia, to 368 F and 5.5 psia. The enthalpy requirement from the steam tables is 64 Btu 1 lb, or a total duty of 11,500 Btu per hr.

The live steam is at a pressure of 154 psia (423 F) and will be lowered to 360 F and condensed. The enthalpy released will be 895 Btu/lb, and the live steam requirement is therefore, 11,500/-895 = 12.8 lb per hr.

Value of live steam if used for *stripping*, at $.2000/M lb

$$= \frac{1800 \times 24 \times \$.2000}{1000}$$

= $8.64 per day.

Cost of live steam, if used for superheating exhaust steam.

$$= \frac{12.8 \times 24 \times \$.2000}{1000}$$

= $.0615 per day.

Saving, assuming that exhaust steam could not have been used otherwise
= $8.58 per day.

If the exhaust steam could have been condensed and returned to condensate had it not been used for stripping, its value would be:

Value of condensate, at $.0220/M lb

$$= \frac{1800 \times 24 \times \$.0220}{1000}$$

= $.9500,

and the saving would be $7.63 per day rather than $8.58.

After determining the heat exchange cost for such an installation the payout time is easily determined as in previous examples.

As steam is generally more expensive than fuels, a more economical procedure on a large superheater duty is the use of a direct fired superheater. One example of this is the Petro-Chem Iso-Flow direct fired heater. Table 2 indicates the relative cost of the smaller size units, and using cost indexes for labor, such as the "Costimating"[3] series recently published, a payout time can be estimated. The prices in Table 2 are based on all welded schedule 80 carbon steel coils with welded return bends. These units are the all-radiant type, and efficiencies are 60-65 per cent.

A few trial calculations with plotting will indicate when to superheat with live steam or with direct firing. Another common method of superheating steam is to install tubes in the box of a nearby furnace. In any case, an attempt should be made to avoid expanding live steam down to a low pressure for process operations, without making use of the available work in doing so.

Item 4(b)—Exhaust steam in low pressure turbines. Consideration of thermodynamic principles indicates that a greater efficiency of any heat-power cycle may be secured by increasing the temperature range through which the cycle is operated. With pumps, this principle is more applicable to reciprocating equipment than to turbines. The reciprocating steam engine utilizes more of the available energy of the steam at high pressure than at low pressure. The turbine, on the other hand, has an advantage at low pressure, or where the ratios of expansion are large, since it operates on a complete expansion cycle. In many cases, therefore, the thermal economy of pumping plants can be improved by installing low pressure steam turbines (particularly condensing) to utilize the exhaust steam from reciprocating equipment.

About the same amount of energy is available for doing work in expanding from a medium boiler pressure down to that of the atmosphere, as there is in expanding from atmospheric pressure to that of a high vacuum. However the expansion is much larger in the second case, and to utilize this expansion, the steam cylinder must be correspondingly larger. Efficiency is not greatly altered for the same horsepower.

TABLE 2. Relative cost of Petro-Chem Iso-Flow furnaces.

Duty, thousand Btu's	Price, dollars
100	1950
150	2050
200	2150
250	2250
525	2750
1000	3450
1500	3700
2000	4400
2500	4950
3000	5650
3750	6300
4000	6450
4500	7200
6000	8900

To illustrate, following is a tabulation of the enthalpies from the Mollier Diagram of steam expanded at constant entropy from an initial pressure of 140 psig with 60 F superheat, to several different terminal pressures.

Pressure	Enthalpy
140 psig	1230 Btu per lb
20 psig	1110 Btu per lb
0 psig	1052 Btu per lb
1.5 psia	920 Btu per lb

By subtracting the enthalpies between two levels and dividing into the Btu-horsepower equivalent, 2545, the theoretical steam requirement per hp-hr is obtained. The steam rate, or pounds of steam per hour per horsepower output (brake horsepower) is then obtained by dividing the theoretical steam by the turbine efficiency. As efficiency is a function of horsepower rating, and several other factors, a true evaluation will not be made here; but using a 50 per cent efficiency, the steam rates for different expansions are shown in Table 3.

TABLE 3. Comparison of available heat from expanding steam.

Steam pressure drop, psi from	to	Btu's available	Theoretical steam required	Steam rate, based on 50% eff.
140	20	120	21.2	42.4
140	0	178	14.3	28.6
140	1.5 psia	310	8.2	16.4
20	0	58	43.9	87.8
20	1.5 psia	190	13.4	26.8
0	1.5 psia	132	19.3	38.6

The last two items of Table 3 are illustrative that wherever exhaust steam is discharging to the atmosphere at any pressure above zero it could advisedly be directed to an exhaust steam turbine, condensing. For single installations, a barometric condenser will probably be found the most economical, even though the condensate ends up in the cooling water system. A surface condenser is of course justified for larger duties, especially if located centrally to a number of units. Low pressure turbines, or equipment for revamping high pressure turbines to low pressure are readily obtainable at nominal prices.

Pump end calculations are of course as commonly used. Conversion of head from feet of water to pounds per square inch, or vice versa is sometimes troublesome. The head, in

pounds per square inch pressure = $\frac{\text{feet} \times \text{sp. gr.}}{2.31}$ but the head, in feet of water = psi × 2.31.

Item (4c)—Use of exhaust steam for refrigeration. The purpose of a refrigeration system is to transfer heat from a low temperature to a high temperature environment. As the required heat flow is in the opposite direction to the natural tendency, work is required to perform the operation. In a vaporization machine, this is done by causing a volatile liquid to absorb heat at the low temperature by vaporization (pressure maintained lower than saturation pressure at the vaporizer temperature), and to dissipate this heat at the high temperature by condensation (pressure held higher than saturation pressure at the condenser temperature). Thus an evaporator, condenser, and some means of transferring the refrigerant are common equipment to any type of vaporization refrigeration machine.

The three common types of refrigeration machines are compression, vacuum, and absorption. In the vapor compression system, the refrigerant is transferred by a compressor driven by a mechanical prime mover. In the water vapor-steam jet system, the refrigerant is pressurized by pressured steam in steam jets. In the absorption system the prime mover is foreign heat. Each of these systems can utilize exhaust steam if desired, rather than high pressure steam. With the compression system, a low pressure turbine and centrifugal compressor with multiple stages is required to obtain the necessary pressure requirement. Large size nozzles or jets are required in the water vapor equipment, if exhaust steam is to be used.

The thermodynamics necessary to design any of these types or refrigeration units may be found in a good mechanical or refrigeration handbook. The use of Stickney charts facilitates the computations in the case of the absorption system. Operating economy is derived from the work ratio, or performance coefficient, i.e., the ratio of the net heat abstracted to the work expended. The horsepower and kilowatts required per ton of refrigeration follow directly from this definition of work ratio, and the conversion factors:

1 hp	=	2,545 Btu per hr
1 kw	=	3,415 Btu per hr
1 ton of refrigeration	=	12,000 Btu per hr
Theoretical horsepower per ton	=	12,000
		2545 x work ratio

The theoretical horsepower is nearly equal to the indicated horsepower, but the brake horsepower will be 10 to 20 per cent higher due to friction, inertia, and other losses. For example, at an 85 F condenser temperature (153 psig) and 0 F evaporator temperature (16 psig), one horsepower is required to produce one ton of refrigeration with ammonia. Economies may be ascertained similarly to that of the turbine study and Table 3 when using steam. The latent heat of the steam is lost to cooling water in the compression system, but is recovered for refrigeration in the absorption system. As the latter is easily adapted to the use of exhaust steam for low temperature refrigeration, a further discussion seems pertinent.

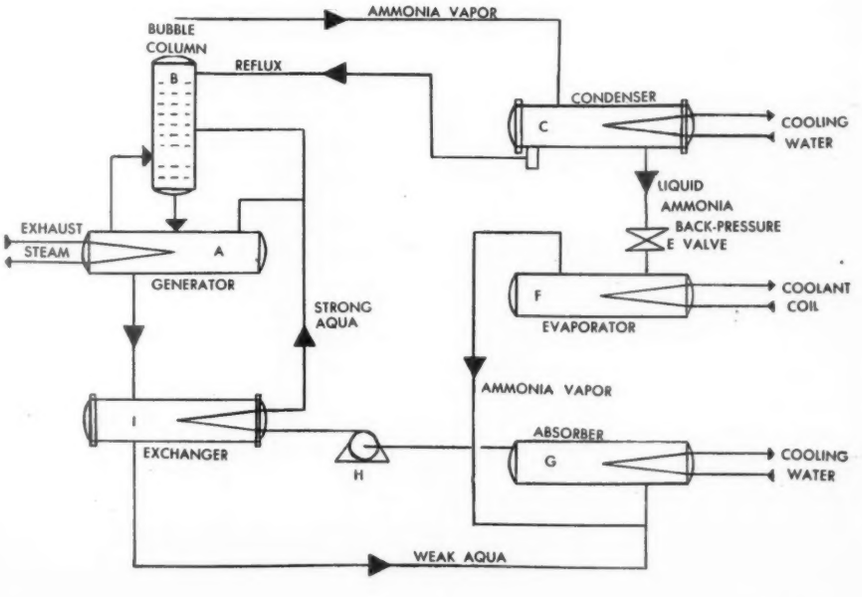
The continuous absorption system has undergone considerable improvement in recent years and probably merits a closer consideration than it normally obtains. This is particularly true in a waste heat study. The tendency of refiners is to "grab" a gas engine compressor for refrigeration because it is convenient. The new design absorption units have eliminated the analyzer and dehumidifier for purifying the ammonia, by using liquid ammonia reflux and fractionation in the bubble column. Weak aqua coolers are usually not necessary, through better exchanger design with the strong aqua, and absorber efficiencies have been greatly improved. Most published flow diagrams in texts and handbooks show designs of the years from 1870 to 1910.

The absorption system is based on the ability of water to absorb large quantities of refrigerant, usually ammonia, which can be released by the application of heat. The absorber compares to the suction stroke of a compressor in withdrawing vapor from the evaporator. The liquid transfer pump and generator compare to the discharge of a compressor in supplying pressure to the condenser. A block flow diagram of an ammonia absorption system is shown in Fig. 1.

The refrigerant is drawn from the evaporator (expansion) coils F at a given pressure p_1 and dissolved in the absorber G where the combined pressure of solvent (ammonia-water) and refrigerant must be less than p_1. The refrigerant is recovered by applying heat to the generator A; separated in anhydrous form by the bubble column B; liquefied in the condenser C; collected in a liquid receiver D (not shown); and returned to the expansion coils F through the expansion valve E. Since the absorber is at a lower pressure than the generator, it is necessary to insert between them a pump H to transfer the strong aqua. Only part of the ammonia (about 8 per cent) is removed from the strong aqua, and the weak aqua solution is returned to the absorber through the heat exchanger I. Heat of solution and latent heat of liquefaction is evolved in the absorber, and must be removed to keep the pressure in the absorber lower than in the evaporator.

As example performance of the ammonia absorption system, using 250 F exhaust steam and at an evaporator temperature of 30 F, a work ratio of 50 per cent may be obtained on a straight absorption cycle. On a resorption cycle, where two operating pressures and absorbers are used, a lower temperature level on the exhaust steam may be utilized (approximately 210 F) but the work ratio would only

FIG. 1. AN AMMONIA ABSORPTION REFRIGERATION SYSTEM



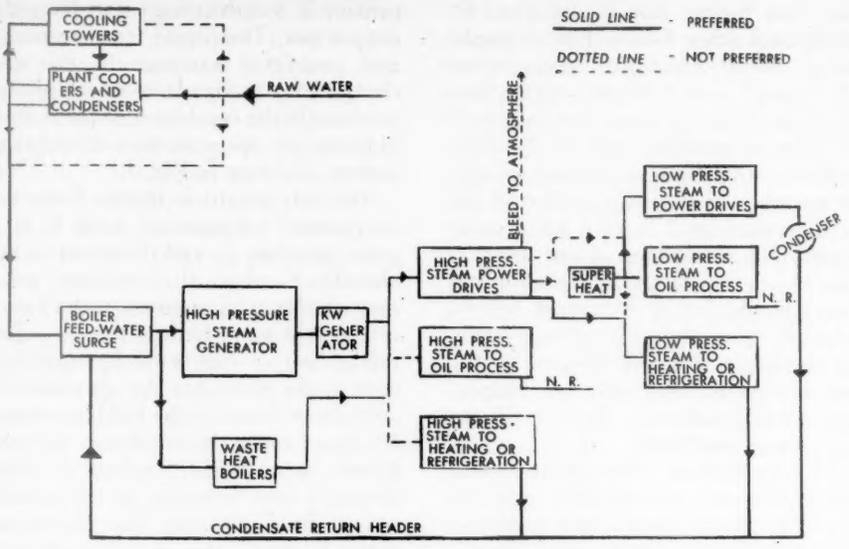


FIG. 2. STEAM PROCESSING FOR WASTE HEAT RECOVERY
*N.R.—Steam not recoverable.

be about 18 per cent, with 85 F cooling water.

Installations are somewhat bulky (although greatly reduced in the new automatically controlled designs) but where waste heat is available, economies over mechanical refrigeration may be obtained. Comparative installation costs are indicated in Table 4, illustrating that absorption type units have an advantage over compression units at low suction pressures and/or large tonnage. A certain large 3450 ton absorption type installation, using exhaust steam, is reported to have cost 70 per cent of what the same tonnage would have cost with compression type refrigeration.

An interesting development in absorption refrigeration is that of using water vapor as the refrigerant and an inorganic salt (lithium bromide) as the absorbent. As the high-boiling salt does not vaporize, there is no absorbent carry-over into the condenser. Efficiency is increased since no heat is lost for re-evaporation of the absorbent. Steam pressure as low as 10 psi may be used.[4]

To make a decision as to which of these types of refrigeration is the most economical a separate study is required for each locality with consideration given for utility availability and cost. An absorption unit, for example, would show particular advantage where waste heat and/or inexpensive cooling water are available. One refrigeration authority[5] has stated that "most refiners could obtain their entire refrigeration requirements from waste heat, but only about 10 per cent of this large group have taken this advantage." The ideal situation is to be able to alternate, partially at least, the winter heating requirement with the summer refrigeration load, utilizing waste heat in both cases.

Item 4(d)—Boiler Feed. Water heating with exhaust steam, above 0 psi, is common practice. Since the use of exhaust steam turbines for boiler feed-water pumping is a "natural" in the same unit area as the feed-water heating, consideration should be given to the use of the exhaust steam from the low pressure turbines for this service. This latter procedure could only be used, of course, when the boiler feed-water temperature is below that of the exhaust steam under vacuum.

Items 5(a) and (b) — Re-routing water streams. The two main heating requirements in refinery processing are: To do work, and to raise the temperature of the materials being processed. Most of the first requirement is accomplished through the medium of steam, and the second by direct heat contact. The heat absorbed for raising temperature must be removed again in cooling water. Ideally then, why not transfer the heat in the cooling water directly into the boiler by routing the feed-water through plant condensers and coolers? Thus heat used for temperature raising will be transferred over to heat required for doing work, rather than wasted to the atmosphere. Obstacles arise, such as contamination but with proper sampling devices at the water effluent of each exchanger and oil-water separators where necessary, this ideology may be realized. Chemical treatment problems must be given full consideration. The prime cost of this type of waste heat recovery is in piping rather than heat exchange surface, so that a reasonable payout is easily obtained unless line distances are excessive.

TABLE 4. Dollars per ton of refrigeration (erected).

Evaporator temp. °F	Compression tons ref. 400	600	1000	Absorption tons ref. 400	600	1000
20	232	200	188	306	262	240
10	256	228	216	318	268	248
0	292	266	254	330	278	258
−10	320	316	300	344	288	268
−20	400	372	352	362	302	282
−30	468	432	408	384	320	298

Conclusions

A waste heat recovery program can range from a few simple changes in operations to a very extensive and complicated procedure. Fig. 2 illustrates a possible power processing flow wherein the most obvious savings from waste heat recovery can be realized.

If only one of each of the calculated examples were capitalized on, excluding most of the items mentioned such as waste heat boilers and refrigeration, the saving, based on the utility costs used in this study, could amount to the following:

One furnace efficiency improved	$ 9.52 per day
One heat exchanger installed	22.90 per day
One shell and tube steam superheater installed	8.58 per day
One exhaust steam turbine installed, 200 hp, 40.0 steam rate	38.40 per day
Saving from proper steam traps	10.00
Total saving	$89.40 per day = $32,631.00 per year

It should be reasonable to expect to obtain at least three times this saving in a given year, which would be approximately 10 per cent of an annual million-dollar fuel bill. Good supervision is an integral necessity in recovering this waste heat, but the saving and the supervision are both well justified.

Increased cooperation between processing industries and equipment designers and manufacturers should, in the future, result in additional developments which will improve the possibility of waste heat recovery.

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5. McGinnis, W. R., private communication.

* * *

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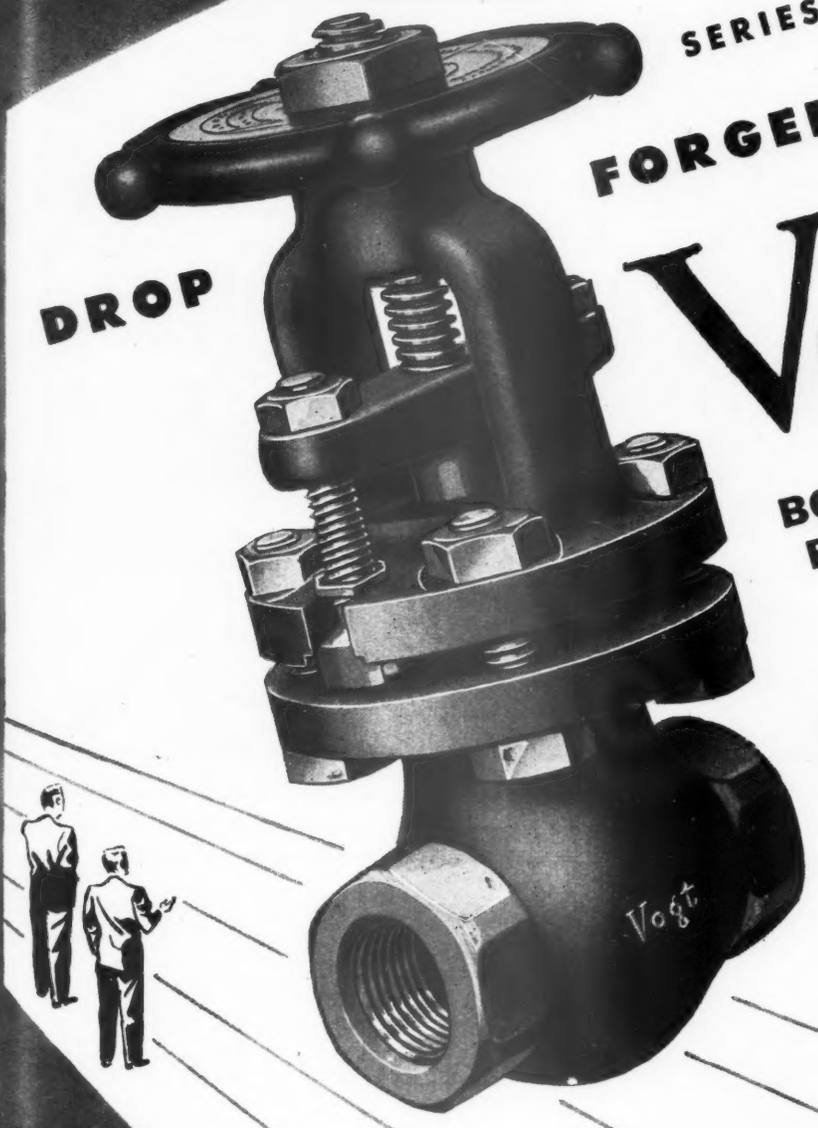

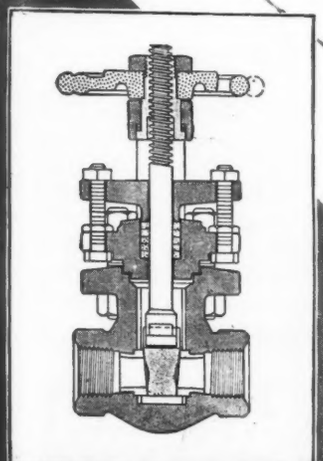

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This aerial photograph shows the major processing units that formed modernization program. Bottom center is the delayed coking unit, with the old thermal coking units just back of it. Beyond the old coking units and to the left is the new catalytic cracking unit, with the treating plant at top center. A part of the alkylation unit is shown top right.

P 710.1

Complete East Chicago Refinery Expansion

ARCH L. FOSTER*

MOVING to the forefront in line with its Lake Charles and other refining centers the East Chicago refinery modernization program of Cities Service Oil Company has been completed and the expanded plant is in operation. Built around a fluid catalytic cracking unit that charges 14,760 bbl of feed per day, and a delayed coking unit (thermal) that produces more than 600 tons of petroleum coke per day, this Kellogg-designed-and-built expansion followed the last addition that was a war-built alkylation and isomerization plant. The entire refinery now processes 35,000 bbl of chiefly Mid-Continent crude daily.

In addition to the catalytic cracker and the coking unit, the program includes a modernized water and sewer system, additional crude storage, expanded gasoline treating capacity, a gas purification and light ends recovery unit, more steam-raising units and several buildings that were much needed in the new setup.

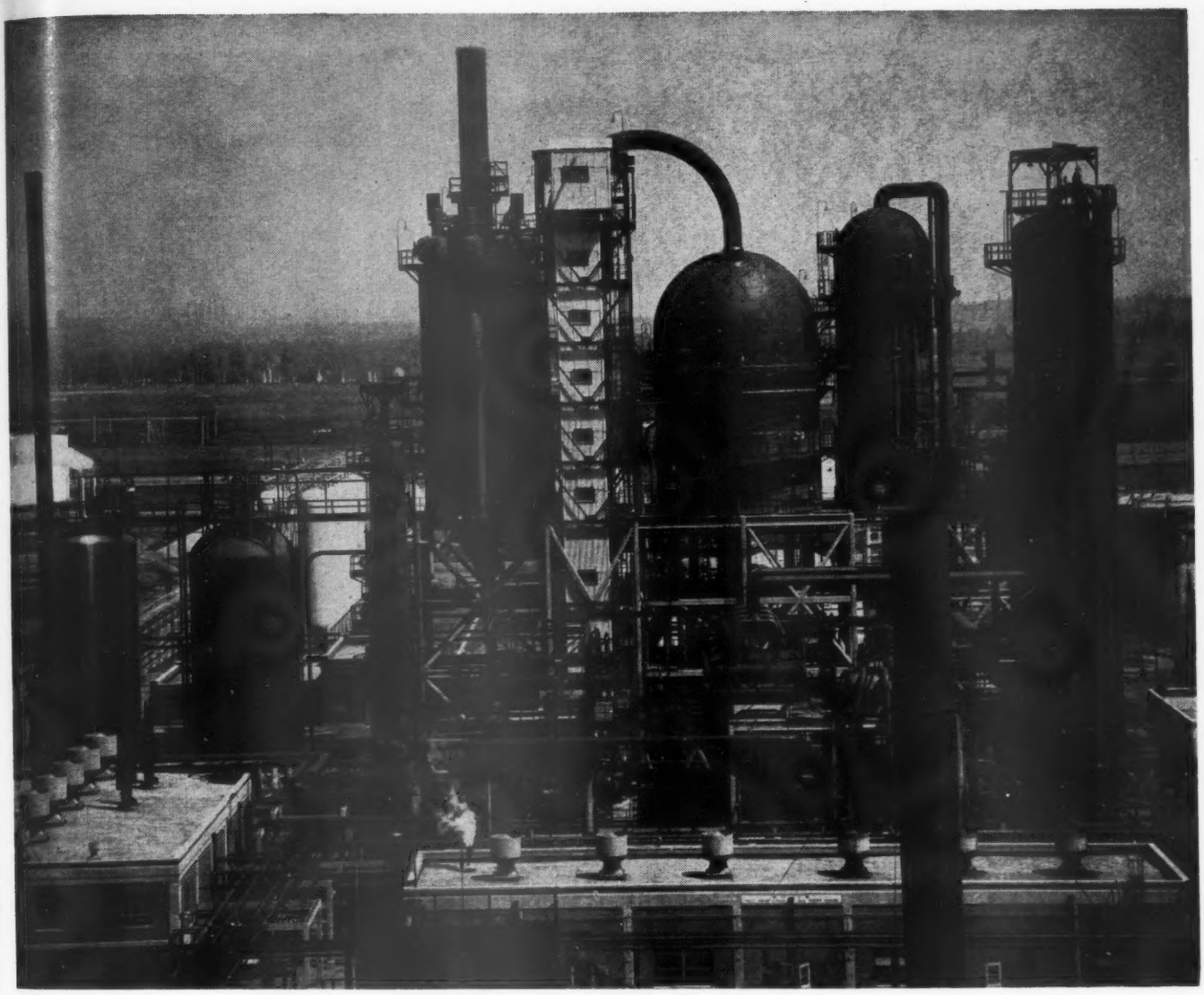
EXCLUSIVE

The old plant included a crude topping unit, pressure coking (thermal cracking) units, the alkylation and isomerization unit, an absorption and light oil stabilization unit, and a treating plant. At a cost of about $20,000,000 the new units make this plant as modern as any in the Cities Service assembly or the industry.

Fluid Cracking Unit

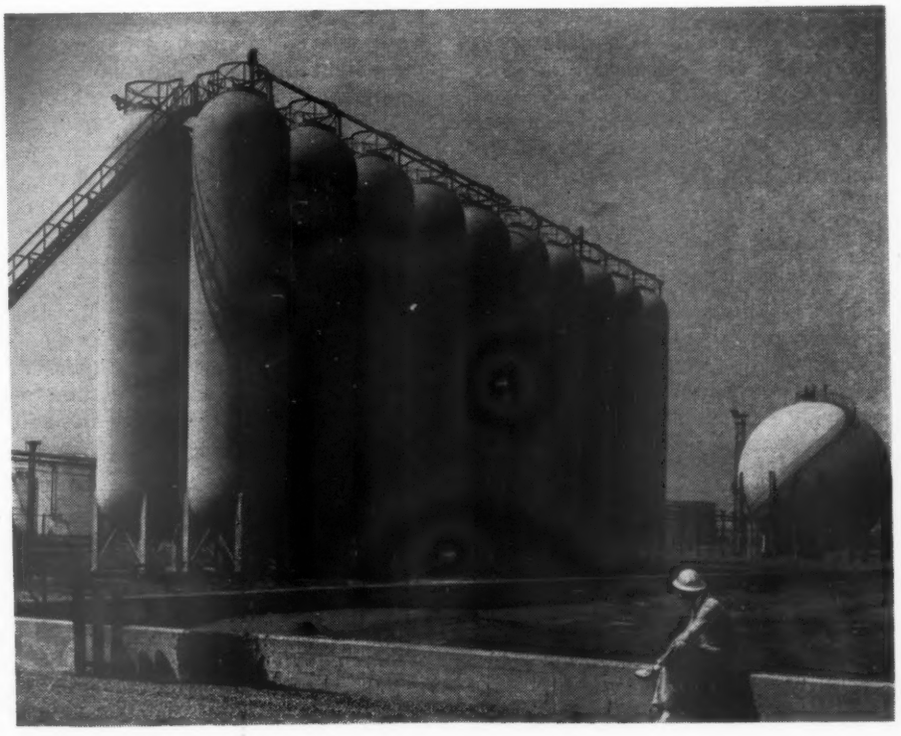
This unit is of the typical improved design, and to it is charged nearly 15,000 bbl per day of topped crude or

*Refinery Editor.



New fluid catalytic cracking unit has a daily capacity for 14,760 bbl of feed stock and 10,300 bbl gas oil conversion.

other petroleum fractions. Auxiliary equipment heats the charge and vaporizes most of it into a gas oil that passes direct to contact with the incoming regenerated fluid catalyst; this stream amounts to at least 10,300 bbl daily. The catalyst regenerator, a vessel of typical design 36½ ft by 35 ft, has a coke-burning capacity of 15,000 lb (7½ tons) per hour. Combustion gases from this burning are led through waste heat steam generating units, producing 110,000 lb of steam hourly. To meet the requirements of this carbon-burning unit the blower capacity of 195,000 lb of air per hour is provided.



Part of the storage at the East Chicago Refinery of Cities Service Oil Co. (Del.) is shown. Bullet storage, left, for butane and natural gasoline; sphere at right for butane.

One of the major processing units in modernization program was delayed coking unit, shown at left. Each of the two coke drums has a capacity of 326 tons of coke and are said to be the largest in use by any U. S. refinery.

Bubble tower at the East Chicago, Indiana, refinery of Cities Service Oil Company.

The "cat" cracker assembly includes a fractionating tower 120 ft by 16 ft; the reactor is 50 ft by 21 ft diam, while the regenerator is 35 ft high by 36.5 ft diam. The delayed coking units, employing thermal cracking for reduction of the charge to gasoline, coke and gases, dominate the plant skyline. The twin coking drums, each 68 ft high and 17.5 ft diam, of 326 tons coke capacity, are surmounted by derricks of the same height, making the overall height of the structure about 160 ft from the lower level of the drums. These derricks are necessary to operate the coke removing equipment. Nearly 70 ft of coke is deposited in each drum in turn. A special cutting tool is supported by the derrick, and cuts a hole through the coke bed. Through this hole is lowered a hydraulic cutting head from which jets of water under very high pressure cut the coke from the bed and drop it into gondola cars set below the open lower end of the drum. This system, developed several years ago and now used widely in coking operations, reduces greatly both the time required for and cost of coke removal. This delayed coking unit has cost in the neighborhood of $3,000,000; the catalytic cracking unit represents an outlay of about $7,000,000.

Several other units make this revamped refinery one of the most modern in the country. A gasoline treating unit provides for washing the distillate with a solution of caustic soda, which is regenerated by heating and blowing with air. The distillate is then treated by the Linde copper chloride process, to eliminate sulphur compounds. A Girbotol unit recovers and eliminates hydrogen sulphide from distillates and vapors by amine absorption, a well-known process.

The new refinery requires much more water than did the older smaller capacity plant, a situation that necessitated expansion of the water system of supply. To obtain a satisfactory supply two miles (11,000 ft) of 4½ ft (54-in.) water line was laid between the plant and the pump house situated on the shore of nearby Lake Michigan. The system now handles 125,000 gpm. A new boiler of 100,000 lb of steam per hour capacity has been installed, which doubles the steam capacity of the plant. To handle the various products from the new units, and to store crude for their charging, 650,000 bbl of new storage of all types were built.

Crude for the plant's needs is supplied mainly from Mid-Continent fields through two trunk lines, that of the Texas-Empire jointly owned line, and the Basin pipe line system. Another unit installed at the plant is a typical API standard effluent water purifying plant, to remove all oil and other undesirable materials from the water to avoid pollution of lake and stream waters.

Adjacent to this refinery, although its cost is not included in the $20,000,000 mentioned, is the new technical service laboratory. The building has 10,000 sq ft of floor space, and the staff will devote its attentions to service for the sales department, product testing and evaluation, and new product development. * * *

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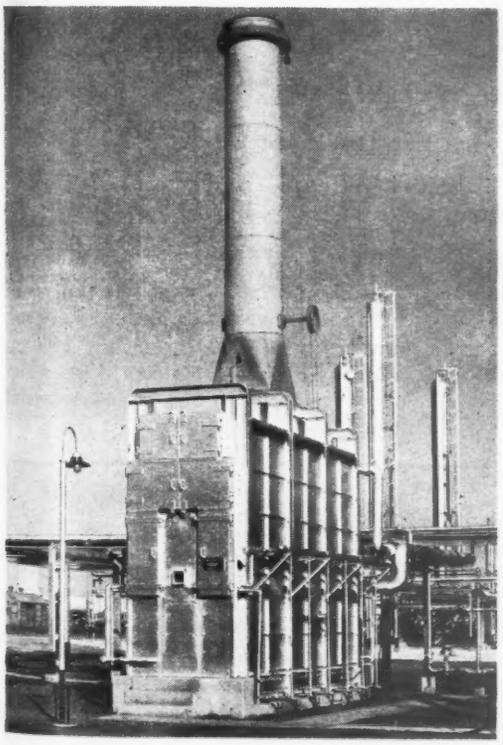

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THE TECHNICAL FORUM

Questions on the petroleum and natural gas industries' technology, chemistry, engineering, and operating problems are answered each month by widely recognized authorities.

Fractionator Instrumentation

Q What are the essential instrumentation requirements for a 50-plate tower for separating pentanes and lighter overhead, a side stream of V. M. and P. naphtha off about the 25th tray, and heavy naphtha as bottoms, from a Mid-Continent straight-run 450 endpoint naphtha, being the whole overhead fraction from a primary crude still?

L. N. G.

A Several assumptions must be made in order to completely outline an instrumentation setup for this column. These are listed below:

1. There is a surge tanke between the crude still and the naphtha column, and this tank is of sufficient capacity to permit independent control of feed to the naphtha column. It is always desirable to be able to control feed to any fractionation column independently.

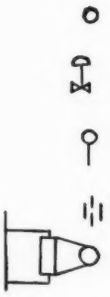
2. An external fired reboiler is used to provide reboil vapor for the column. An internal coil using high pressure steam could have been used, or the feed could have been flashed prior to entrance into the column. It is felt that the above choice is a good compromise between maximum economy and good column operation.

3. No stripping steam is required in the column itself, but a steam stripper is included in the V. M. and P. naphtha product stream. This stripper is used to give more precise control of the ibp of the naphtha stream. This is an important consideration for this product.

4. A partial condenser is used on the column overhead, and the net overhead of pentanes and lighter is recovered from the reflux accumulator as a vapor.

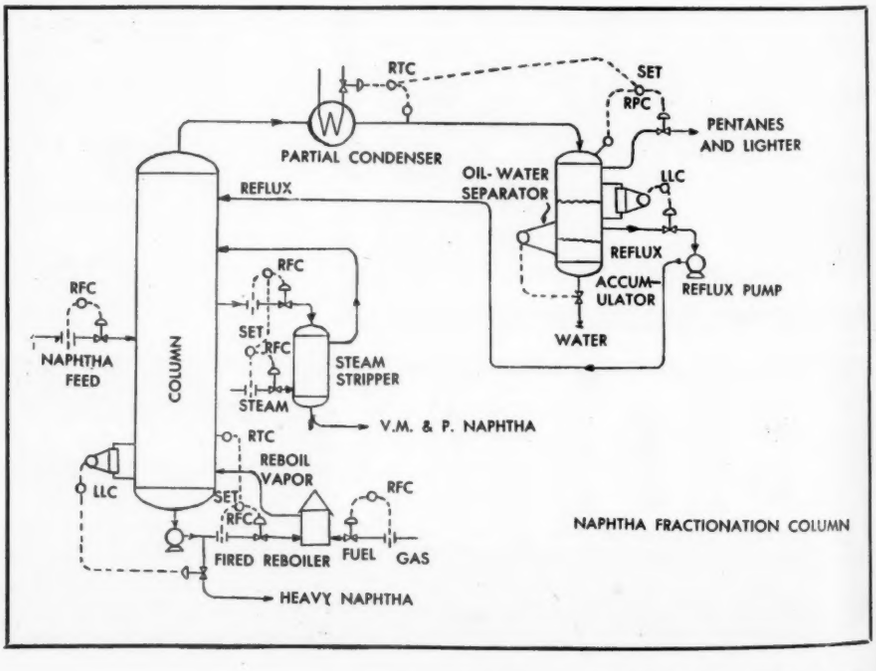
The following symbols are used on the flowsheet in Fig. 1 to designate the control application:

RFC—Recording flow controller
LLC—Liquid level controller
RTC—Recording temperature controller
RPC—Recording pressure controller
Set —This refers to a secondary controller, the control point of which is set by a primary controller. The primary controller in each case is shown connected.



—Controller
—Pneumatic diaphragm control valve
—Pressure or temperature point
—Orifice type flow meter
—Liquid level float

It should be pointed out that even with the above assumptions, there are numerous ways in which the column could be instrumented. The setup shown in Fig. 1 is for precise control,



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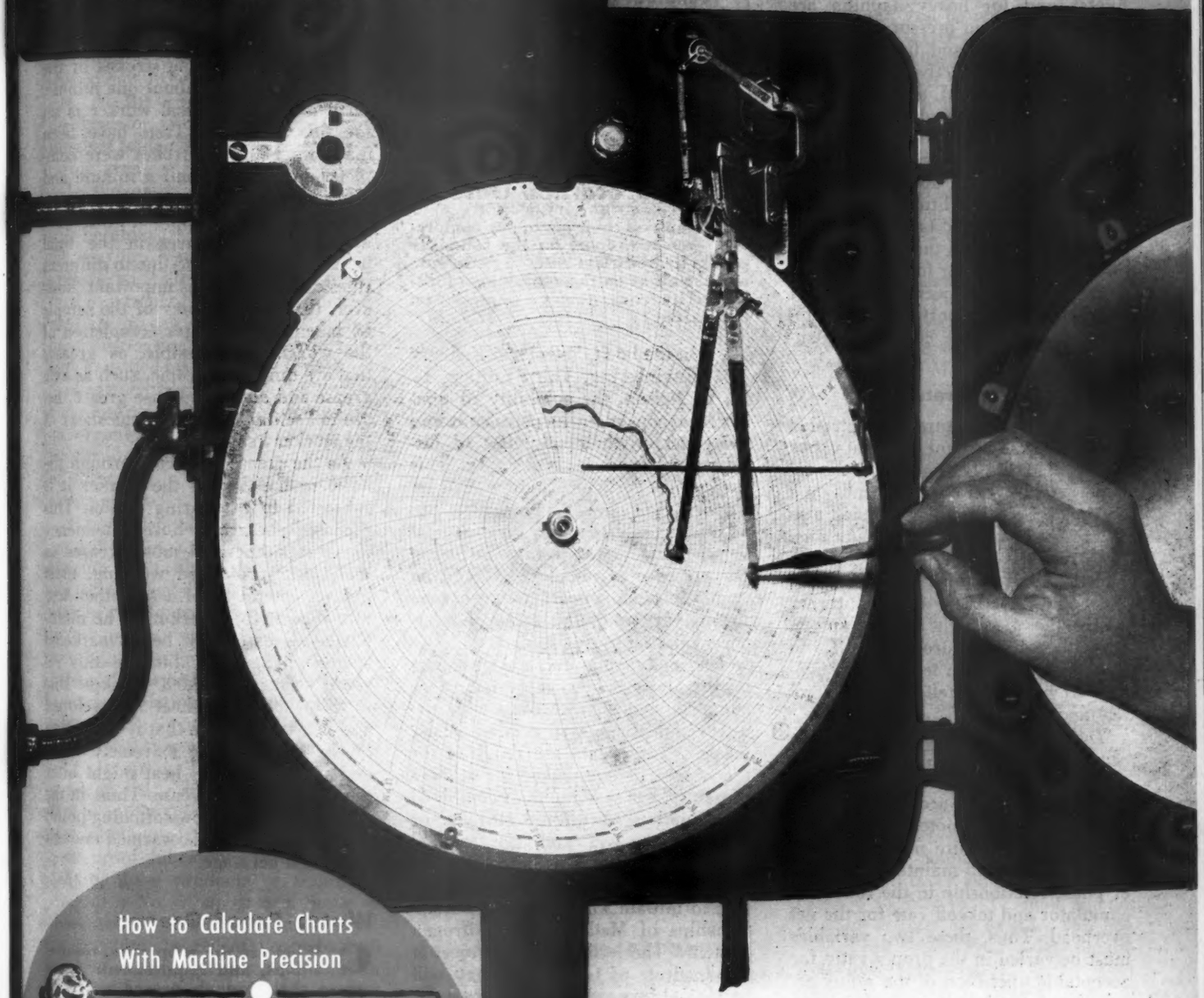
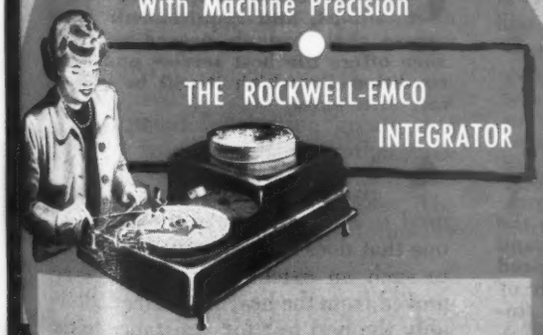


How to Calculate Charts With Machine Precision



This machine mechanically calculates the extension of various makes of orifice meter charts—up to 300 average charts a day. The extension appears as a total on a straight reading register. The operator traces colored lines over the static and differential records to verify results. Machine will duplicate in the office the accurate record made by the orifice gauge in the field. Write for bulletin 1016.

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which is indicated by a 50-plate fractionation column. It will be pointed out in the description of the installation, below, where fewer instruments could be used, at the expense the quality of control. Depending on the feed composition and the product specifications, this step might be indicated.

Pressure

The rates of takeoff for pentanes and lighter and for heavy naphtha are seen to depend on pressure in the reflux accumulator and liquid level in the columns, respectively. Thus the takeoff rate for V. M. and P. naphtha is set by a flow controller. During an upset in column conditions the control point for this controller may have to be adjusted in accordance with other operating conditions at the time. Note that the rate of takeoff of V. M. and P. naphtha sets the control point on the flow controller for the stripping steam. If the ibp specification is not considered too important, this stripping steam may be controlled manually.

Temperature

Column temperature is controlled by varying the amount of reboil vapor returned to the column from the reboiler. As the reflux rate depends on a liquid level control, this provision also takes care of variations in reflux rate. Note that the temperature controller sets the control point on the rate of flow controller. The flow controller on the fuel gas might also be tied in with the temperature controller to give somewhat better temperature control. However, it is felt this step is not justified.

The temperature controller in the effluent from the partial condenser sets the control point for the pressure controller on the reflux accumulator. It is very important to note that the pressure and temperature may not be set independently and maintain the proper phase relationship in the reflux accumulator and takeoff rate for the net overhead. Thus, these two variables must be varied in the proper ratio for acceptable operation of the reflux accumulator. It might be possible to control this pressure manually, depending on the number of upsets in column operation. This is not recommended however.

Another possibility in instrumentation of this column is that the control points of all other primary controllers be set by the flow controller on the column feed. In this manner, proper compensation for a change in feed rate is made automatically throughout the system. For this installation, however, this step is probably not justified.

A. M. Platt and G. L. Farrar.

Ask The Forum

You can ask any questions in this department and get answers from the leading scientists and engineers in the refining and gas processing industries.

Address your questions to **Technical Forum Editor,** Box 1589, Dallas 1, Texas, and you'll have an immediate answer before publication.

Solubility of Non-Hydrocarbon Gases

Q Can you refer me to any comprehensive report on the solubility of non-hydrocarbon gases in petroleum and the effect on their solubility of dissolved hydrocarbons (e.g. methane, ethane, etc.)? *H. L. J.*

A In the book, Petroleum Refinery Engineering, Third Edition, by W. L. Nelson, the solubility of non-hydrocarbon gases in petroleum and the effect on their solubility of dissolved hydrocarbons is discussed. This work is set forth in Chapter XVI on Vaporization and Condensation. In addition to discussing the general vapor-liquid relationship including the presence of an inert gas and an immiscible component, Nelson has set forth a very up-to-date series of references relating to this subject.

Thermodynamic and physical data on the above subject is by no means complete and that dealing with the nitrogen-methane system is especially meager. These data are required for the design of equipment for storage of natural gas as a liquid, or combined fractionation and liquid storage, or nitrogen removal and transmission without storage. This situation has prompted the American Gas Association to initiate work on "P-V-T Relationships of Methane with Nitrogen System." The results of this project at the Institute of Gas Technology will be looked forward to with interest.

Frank H. Dotterweich.

Work Greases

Q Why "work" greases? Which is better, high or low speed working, and why the choice? What is the optimum length of working time and what is the relationship between speed of the working implement, length of working time, and texture of the finished grease obtained. *E. C. B.*

A Lubricating greases are "worked" primarily because, by so doing, a more reliable measure of the consistency is obtained than if an "unworked" test were made. Since it is impractical always to take the consistency of a grease in the original container, the product is disturbed in transferring to a cup in which such a test is to be made. By specifying 60 double strokes in a standard grease worker before a test is made for consistency, the irregularities due to variations in handling by different operators are equalized.

The standard method for this test (A.S.T.M.-D 217) calls for completion of 60 full double strokes of the perforated discs in about one minute. Likewise, a mechanical worker is set for this rate also. Tests have been made when the 60 strokes were completed in less than half a minute and also in two minutes on different portions of the same sample of grease. No appreciable differences in the final penetration was found due to different rates of working. It is important, however, that a consistency of the sample be taken as soon after completion of the working as possible, as greases that are quite thixotropic, such as axle grease and aluminum base grease, begin to "set-up" as soon as the shear of the worker has ceased.

As the grease is forced through the holes in the disc of the worker it is subjected to a shearing action. This repeated shear will have a tendency to shorten fibers in most greases so that, after prolonged working, most greases should be of a smoother texture than before working. The multipurpose greases now being marketed should change very little in this respect, even after 10,000 strokes. Due to this shear some heat is developed and it is conceivable that if the action of the worker were extremely rapid and prolonged, this heat might alter the texture of the grease. Thus, in the case of a grease of low softening point, the product might be warmed enough to reach a gel stage.

B. & M.

Water-Proof Grease

Q What are the properties, compositions, and requirements for a grease that through proved performance offers the best service under the conditions in which it will be in contact with water. *M. E. E.*

A A lubricating grease that will give satisfactory service when used in contact with water should be one that does not emulsify or thin out to such an extent that it will be removed from the bearing surface. Probably the best test for resistance to the action of water is one called for in certain government specifications such as AN-G-15a. This consists of packing a 204k Conrad type ball-bearing with

4.0 grams of lubricating grease, clamping this bearing in a case held on a horizontal shaft that is rotated at 600 rpm, the inner race turning freely. A plate covers the end but a clearance of 0.01 in. is provided around the clamp on the end of the shaft. A stream of distilled water is directed at a point approximately ¼ in. above the opening in the cover plate while the bearing rotates for one hour. The stream of circulating water is forced through a 1 mm capillary at the rate of 5 ml per second. The initial temperature of the water is that of the room and it should not exceed 120 F during the test. At the conclusion of the test the bearing is removed, dried, and weighed to determine the loss of lubricating grease.

In the above test it is found that most products made with soda soaps will be almost entirely removed from the bearing. A number of lubricating greases will show little removal due to the action of water. Among these are barium, calcium, and most lithium base lubricating greases. To this list may be added oils densified with asbestos floats, carbon blacks, fine silica, or bentonite to which has been attached an organic radical. Graphite is also an aid in resisting the washing action of water if it is incorporated in lubricating greases.

Not only should the lubricant resist emulsification or washing from the bearing but it should also prevent rusting of the metal. Prevention of rust may be due to excluding water entirely or in case water does reach the metal, the presence of a rust inhibitor. An accelerated test for such a quality consists of coating polished steel panels with a thin coat of the lubricating grease and then subjecting the panels to a salt spray. The most satisfactory products will prevent rust for at least 100 hr under these conditions.

A number of years ago almost all waterproof lubricating greases were calcium base products of a consistency of a No. 5 cup grease. Some of these also contained free tallow, wax, or graphite. In recent years barium base lubricating greases have done an outstanding job when used in contact with water.

Klemgard (1) gives a formula for a waterproof lubricating grease that is made from fatty acids rather than fat. Also, an excess of hydrated lime is employed in the manufacture. The resulting product has the following characteristics:

Per cent free alkali, $(Ca(OH)_2)$	0.50 to 1.75
Per cent water	5 to 7
Penetration, worked	160 to 210

A cube of this grease approximately one inch square was not appreciably deformed, melted or dissolved after being boiled with tap water for twenty minutes.

Specifications for two lubricating greases that give satisfactory service when in contact with water are given below:

Soap kind	Calcium	Barium
Soap per cent max.	26	20
Water per cent max.	2.5	0.1
Viscosity of oil	100 min SSU	400/450 @ 100 F
Ash max.	4.0	8.5
Min. dropping point	210 F	375 F
Penetration, worked	175/205	265/295

For stick lubricants in valves used for high pressure steam, calcium soaps are made from vegetable oils and vegetable waxes and this soap, ground to a fine powder, is mixed with high flash oil. Some graphite may also be added. Castor oil and carnuaba wax are suitable materials from which to produce the above soaps.

Reference: Klemgard, Manufacture of Lubricating Grease, Reinhold Publishing Company, 1937.

B. and M.

Viscosity of Distillate Fuel Oil

Q I have been unable to find the viscosity of Mineral Seal Oil, or No. 2 fuel oil, at 90 F and atmospheric pressure. Will you please provide me with this viscosity under the given conditions?

A In reply to your letter asking for information on the viscosity of Mineral Seal Oil or No. 2 fuel oil at 90 F and atmospheric pressure, the viscosity will vary somewhat, depending on the crude source of the oil. Available data, however, indicate that a Mid-Continent straightrun No. 2 burning oil of 35-40 API gravity and 550 F mid-boiling point will have a viscosity of 4.0 to 4.6 centistokes at 90 F. It is believed these values are typical for this type product.

Anon.

Freezing Hydrocarbons

Q Please refer to us any available data on the freezing pure, dry (water-free) gaseous hydrocarbons at temperatures well above the critical under extreme pressures. We have seen data on the freezing of nitrogen at up to zero degrees Centigrade (mentioned by Bridgeman and measured by Benedict), but cannot find reports of similar behavior of the individual hydrocarbons.

C. C. A.

A An examination of the Chemical Abstracts, 1917-1949 reveals no data on the above phenomena as applied to light hydrocarbons.

Alan S. Glendening.

Treating Burning Oils

Q What is the best method for treating burning oils from sour crudes, with special reference to comparison of acid treating with other practicable methods?

W. R. A.

A The treatment of burning oils from sour crudes has many combinations of acid, alkali, lime, clay, filtration, and additives. Oils from sour crudes contain acidic compounds that should first be removed by a 5 to 8 per cent NaOH to form water soluble sodium salts. Strong NaOH forms oil soluble salts that increased color, gum and sediments develop more rapidly in storage. If the refiner desires to check this difference of weak and strong NaOH treatment, one liter of butane treated and evaporated will pass the copper strip corrosion test and fail to pass this test using strong NaOH same percentage volume to the butane. This causic soda solution is readily tested by titration with phenolphthalein and congo red indicators and should be withdrawn at 50 per cent based on Ml (congo red) minus Ml (Phenolphthalein) divided by Ml (congo red).

A convenient soap test for fuel oils indicates the presence of soap or scum forming materials that may cause color or interference of screens in domestic burners. The reagent is 5 grams of ferric sulfate per gallon of distilled water and should be filtered about 48 hours to give a clear solution. Procedure: Mix 2 oz of the oil sample and one ounce of the reagent in a 4-oz chemically clean oil bottle. Shake vigorously for 15 sec and observe these 4 points: Rate of separation, appearance of oil layer, appearance of water layer, and amount of scum formed. Results can be reported as follows: Good—rapid separation, oil layer cloudy, water layer clear, no scum at interface of oil and water layers. Fair—complete separation in 3 minutes, oil layer cloudy, water layer clear to slightly milky, small amount of scum at interface or sides and bottom of test bottle. Poor—slow separation, oil layer cloudy, water layer milky or filled with large amounts of scum. Very poor — scum does not break on rotating the test bottle.

Sulfur, oxygen, or nitrogen compounds are generally present in color formation of burner oils. Subsequent acid treatments of 5 to 10 lb per barrel, mixed lime and clay filtrations to remove acidic residue require both equipment and chemical costs. If soap tests show improved results from any combination of these treatments, the burner oil should be treated with current production for best over all results.

C. W. Rippie.

NEWS

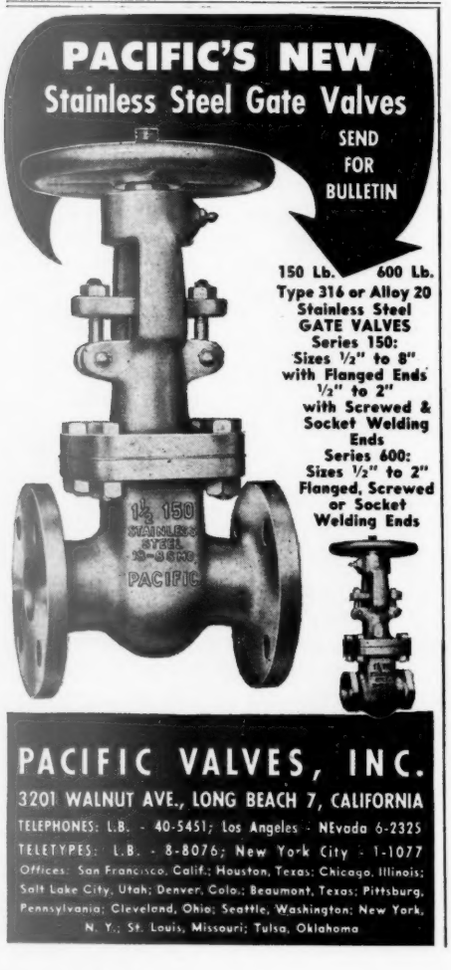
Scurry to Have Gasoline Plant

Work is to begin soon on the largest gas conservation project in the Scurry County, Texas area. Completion for the proposed 67,000,000-ft per day gasoline plant is set for next spring.

The new plant will be operated by Sunray Oil Corporation for the 35 operators participating in the project. The plant, to be built on the Von Roeder farm northwest of Snyder, is expected to yield more than 450,000 gal of liquid products daily. This is based on a yield of around 7 gal per 1000 ft of gas.

New Grease Testing Machine

Analysis of the performance of greases in roller bearings is facilitated by a new testing machine developed by The Texas Company research scientists. The system determines performance of lubricating greases in roller and ball bearing assemblies, over a wide range of temperatures and under high-speed stroboscopic light. Machine includes a high-speed motor-driven shaft, a shielded ball bearing in an electrically heated oil bath, regulated up to 300 F and higher.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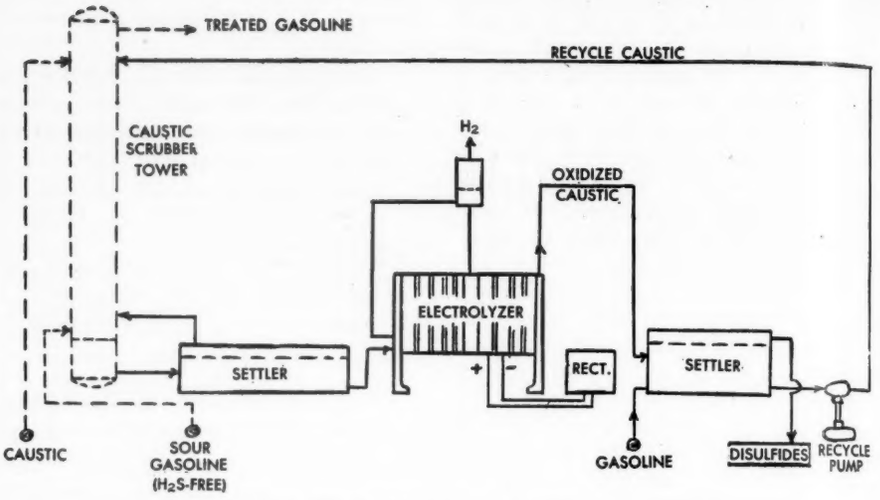

Flow diagram for Gaylor caustic recovery process.

Caustic Recovery Process Introduces New Development

THE Gaylor caustic recovery process introduces a new development, so far as practical full-scale refinery processes are concerned. It employs the "nascent oxygen" generation principle for the oxidation of mercaptans and other organic sulfur impurities, as removed from light products in refining.

Spent caustic is settled to remove any entrained hydrocarbons and is then sent to an electrolyzer, passing between charged electrodes that are separated by insulating diaphragms permeable to liquid but not to gases. From these electrodes hydrogen is released at one point, and may be collected for use in other processes, or may be sent to the atmosphere as waste. Oxygen is liberated at the other electrode (anode), and reacts directly with the mercaptans present in solution in the caustic to produce disulfides. These disulfides are insoluble in the caustic, separate out, and may be drawn off to separate run-down storage. (Separation is facilitated by transferring the mixture to a settling tank, and further aided by adding a small stream of gasoline continuously to the settler.)

Regeneration of the caustic takes place at atmospheric temperatures, requires no heating or steaming. Low power consumption is assured because of the need for only low pressure to send the solution through the electrolyzer. Low-voltage power of high current density, just enough to liberate the required amount of oxygen to oxidize the mercaptans actually present, is employed, and may be obtained by means of a rectifier or a motor-generator set. The inventor claims that a 50-70 per cent mercaptan conversion may be attained when passing solution through at a fairly rapid rate, and that the percentage conversion is increased at lower flow rates. An efficiency of 0.6 lb sulfur per kwh of power used. Among the advantages claimed for this process are reduced operating, investment, and maintenance costs, increased life of the caustic solution and savings in tetraethyl lead requirements for the gasoline treated with the caustic.

The process is developed by American Development Corporation of 201 East 57th Street, New York 22, of which Joseph H. Salmon is president, Dr. C. W. Rippie, vice president and research director, and Peter J. Gaylor, inventor of the process, is secretary-treasurer.

National Refining Company Provides Ear Stopples

As part of its over-all safety and health program for employees, the National Refining Company, Findlay, Ohio, supplies employees working in areas subject to unavoidable industrial noise with Flents anti-noise ear stopples. Boilermakers and workers in the tank car repair departments find ear stopples of value in the prevention of nervous tension and loss of efficiency resulting from noise.

Flents are small, pliable balls of wax and cotton that are easily molded to seal the ear completely and are claimed to reduce surrounding noise levels at least 40 per cent.

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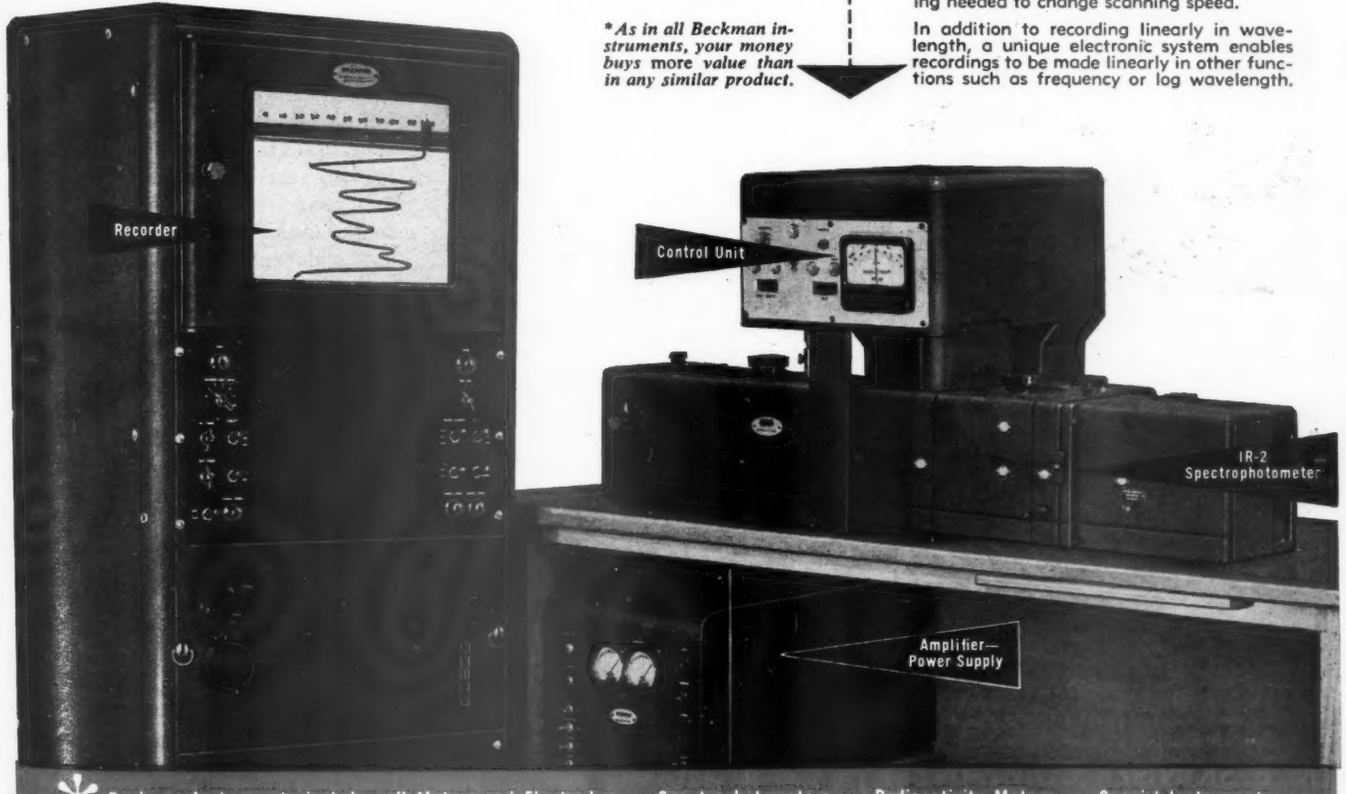
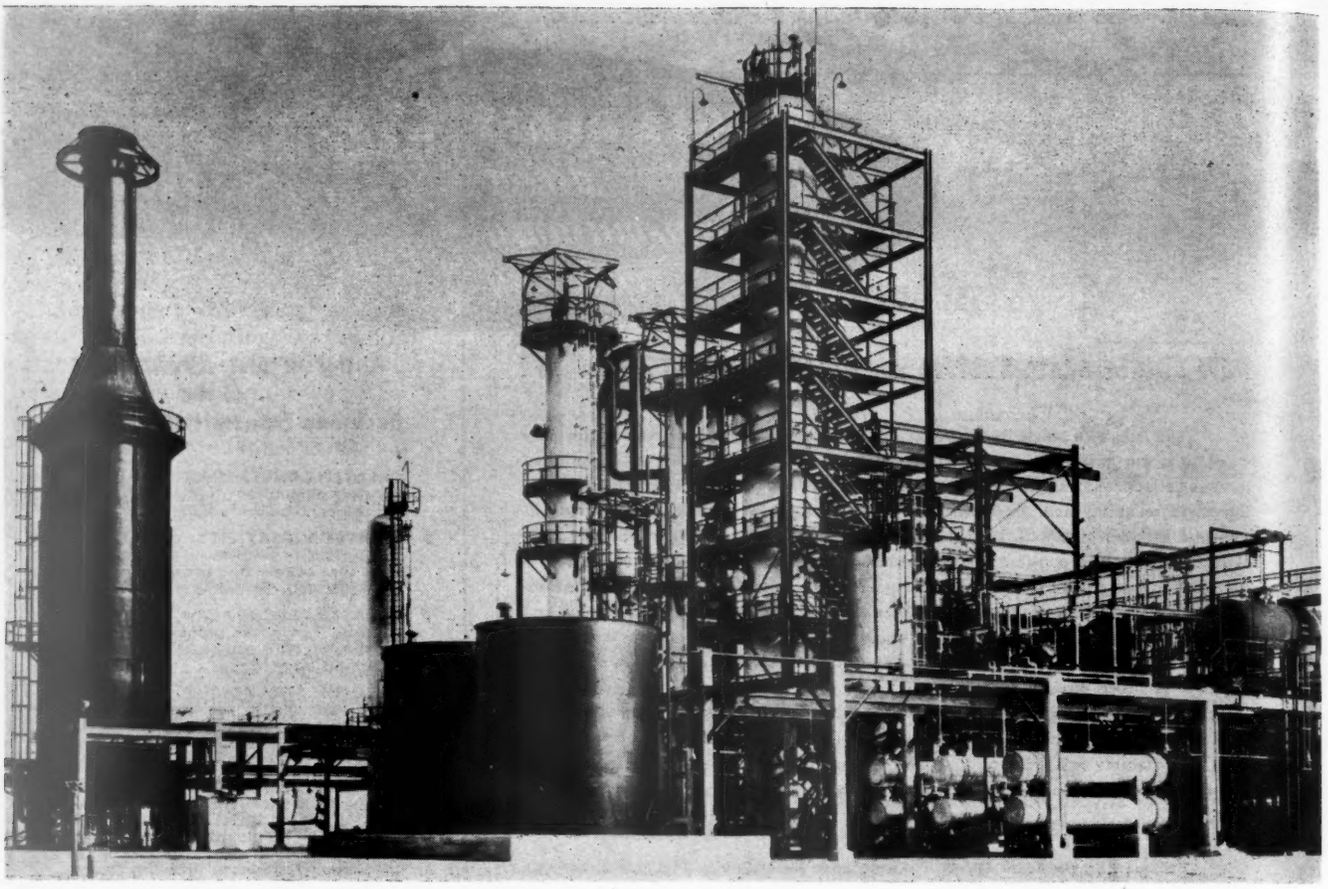
- **GREATER VERSATILITY:** Greater versatility and simplicity and lower costs are assured, since special cells and attachments need not be duplicated for use in a reference beam.
- **GREATER ACCURACY:** The single-beam principle eliminates problems of making a beam attenuator achromatic, linear and free of vignetting effects.
- **MINIMUM STRAY LIGHT:** Only these single beam instruments use a filter-type beam chopper, reducing stray light effects to a minimum (less than 2% at 15 microns with the IR-2).
- **MINIMUM SCANNING TIME:** Optimum recording efficiency is achieved because each spectral slit width is traversed in a time proportional to the response period of the recording system. Any other scanning rate loses either resolution, time or accuracy.
- **MAXIMUM RESOLUTION:** Slit width control has the advantage that the instrument is always working at maximum resolution for the chosen amplification and scanning speed.
- **FLEXIBILITY OF CONTROL:** Operating speed, resolution and chart scales can be easily varied over wide ranges. A single control adjusts scanning time per spectral slit width from 1 second to 128 seconds by factors of 2. The wavelength motor speed is electronically controlled with no gear shifting needed to change scanning speed.

In addition to recording linearly in wavelength, a unique electronic system enables recordings to be made linearly in other functions such as frequency or log wavelength.



Beckman Instruments include: pH Meters and Electrodes — Spectrophotometers — Radioactivity Meters — Special Instruments



The first commercial unit using furfural as the extraction solvent for production of diesel and home heating fuels.

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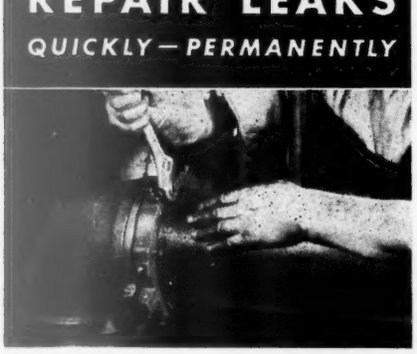

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Texaco Announces New Use For Furfural Process

The first commercial use extraction unit employing furfural as the solvent and specifically designed for the production of diesel and domestic heating fuels has been announced by Michael Halpern, vice president in charge of refining, The Texas Company. Widely used by the oil industry for the removal of sludge producing elements in motor oils, the furfural process has been adapted to the new use in a commercial unit operated by The Texas Company at its new $60,000,000 refinery at Eagle Point, New Jersey, Halpern reported.

He stated that the basic value of the new application is seen in substantial improvement of cetane number in diesel fuels, improved burning quality of domestic heating fuels, and the reduction in sulphur content of all products.

Develop Tank Coatings

A new type of polyethylene plastic coating for the protection of tanks and other equipment in the petroleum and other industries has been perfected by Houghton Laboratories of Olean, New York. This new coating is flame-sprayed onto the surface to be protected, in films of 1/32-in. to 1/4-in. thickness, and the method of application eliminates danger of pinholes in the coating that will permit initiation of corrosion.

When applying the coating powdered polyethylene is blown through a flame onto the sandblasted surface, forming the non-porous film. This film is odorless and completely non-toxic. Pilot plant testing has been under way for two years; the Houghton company will coat new tanks, supply already coated tanks, or will supply equipment materials and personnel for coating tanks in the field.

Blaw-Knox Will Build Chlorine and Soda Plant

Chemical plants division of Blaw-Knox Company has been awarded a contract by Mathieson Hydrocarbon Chemical Corporation, of Baltimore, Maryland, for the engineering and procurement of a large new chlorine and caustic soda plant to be situated at Saltville, Virginia.

Expected to go into operation in 1951, the design will be based on the Mathieson mercury cell process, which produces chlorine and rayon grade caustic soda of 50 per cent concentration directly from the cells. Chlorine is widely used in the manufacture of organic and inorganic chemicals.

Standard Gets Mammoth Vacuum Flashing Unit

As part of a general modernization program at its Richmond, California refinery, the Standard Oil Company of California has awarded a contract for what is considered the world's largest vacuum flashing unit to The M. W. Kellogg Company. The unit will be able to charge 55,000 bbl of reduced crude a day.

The main vessel in the unit will stand 80 ft high and will have a maximum diameter of 27 ft. Its design capacity is believed to exceed by 15 per cent the largest vacuum unit currently in operation.

The unit is being designed to provide approximately 30,000 bbl of feed each day for the existing catalytic cracking unit at Richmond, which is scheduled for revamping during the modernization. Asphalt, the other major product from the flasher, will be charged to visbreakers to produce high quality fuel oil and gasoline.

Scheduled for completion in May of 1951, the new unit will charge not only reduced crude but will also process some heavy, so-called "non-refinable" crudes.

New York University Offers Catalysis Course

The graduate division of New York University College of Engineering will institute a new course called "Industrial Catalysis" during the first term of the academic year 1950-51, Dean Thorndike Saville has announced.

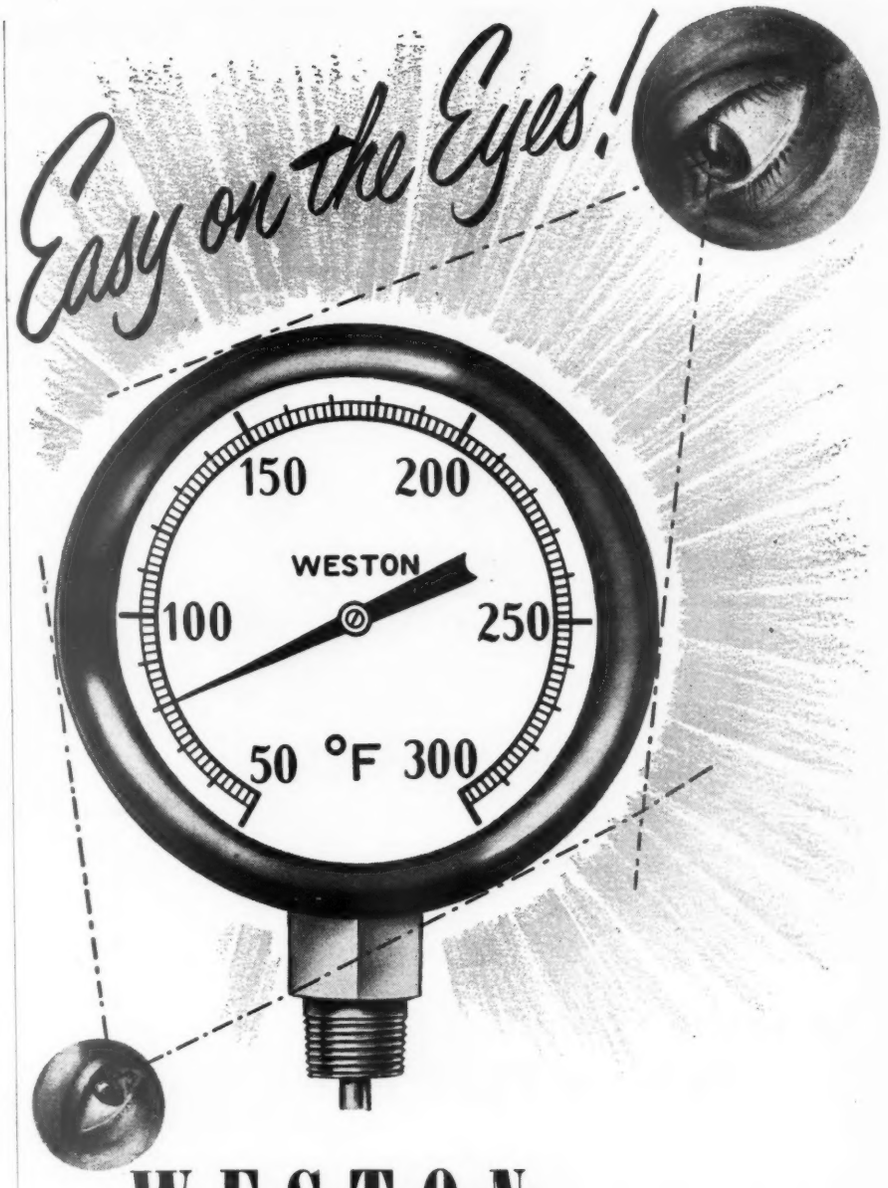
The course will consist of 15 lectures given at Washington Square on Monday evenings by outstanding men in education, government, and industry.

Union to Construct Asphalt Refinery

Union Oil Company has begun construction of a million dollar asphalt refinery at Edmonds, Washington. The refinery, which will have an annual capacity of 65,000 tons of paving asphalts, road oils and cutbacks, will be completed by June, 1951.

"The constantly increasing activities in the Pacific Northwest in industry, irrigation projects, and highway construction have made it necessary for the company to construct this new refinery in order to better serve this growing area," Ruse H. Taylor, president, stated.

Construction of the refinery, including blending tankage and shipping facilities, will be handled by the Bechtel Corporation. The crude oil will be shipped by tanker from California.



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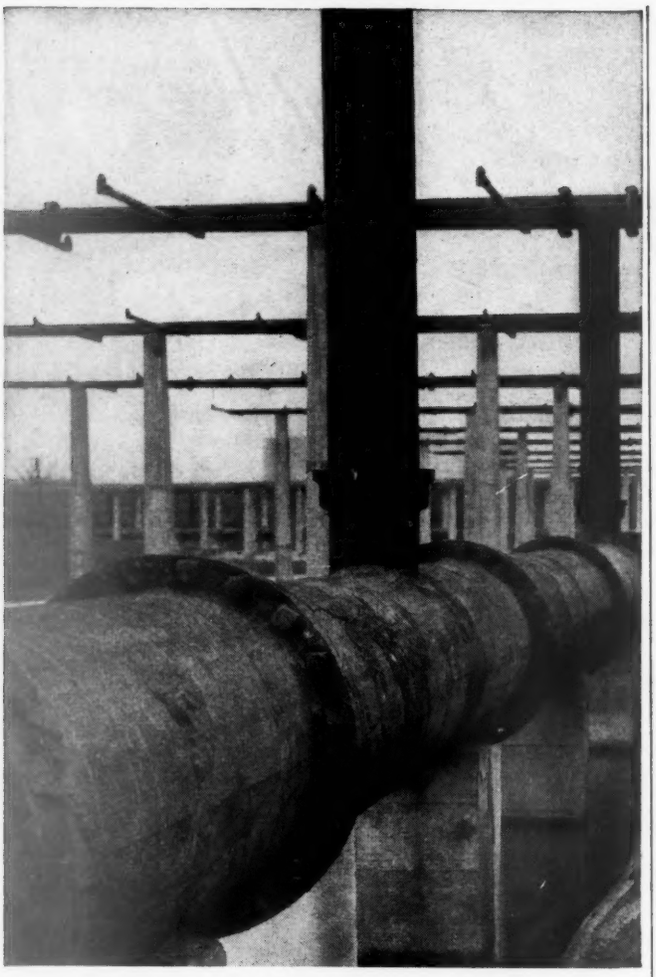


AN ECONOMY FACTOR
IN REFINERY OPERATION

Proved long life and stubborn resistance to corrosion make cast iron pipe a contributing factor in lowering plant maintenance per barrel of crude. Replacing shorter-lived pipe with cast iron pipe has demonstrated this in many refineries. Cost per term of service decreases. Interference with production, caused by frequent replacements, ceases to be a headache. Cast iron pipe works hand-in-glove with plant management to keep maintenance cost down in many refinery operations. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

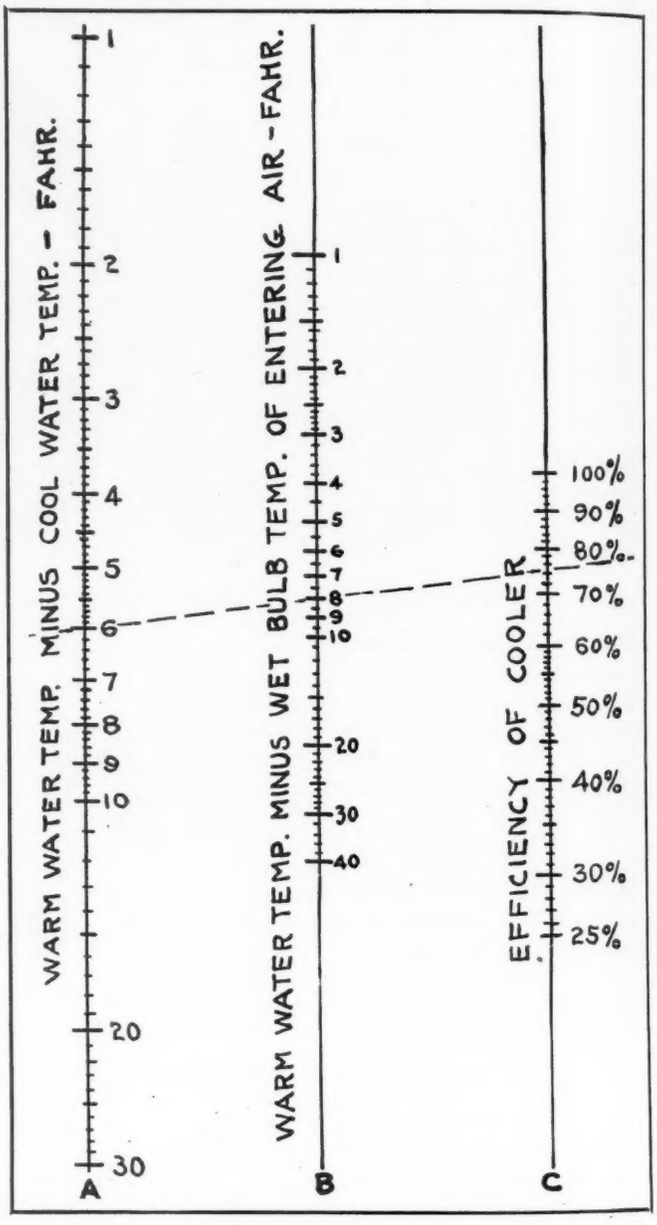
Cooling Tower Efficiency

Herewith is a chart for determining cooling tower efficiency. The chart is used as follows:

Subtract the temperature of the water after it is cooled from the temperature of the same water before cooling and locate the difference in Column A.

Then subtract the wet bulb temperature of the entering air from the temperature of the water before cooling and locate the difference in Column B.

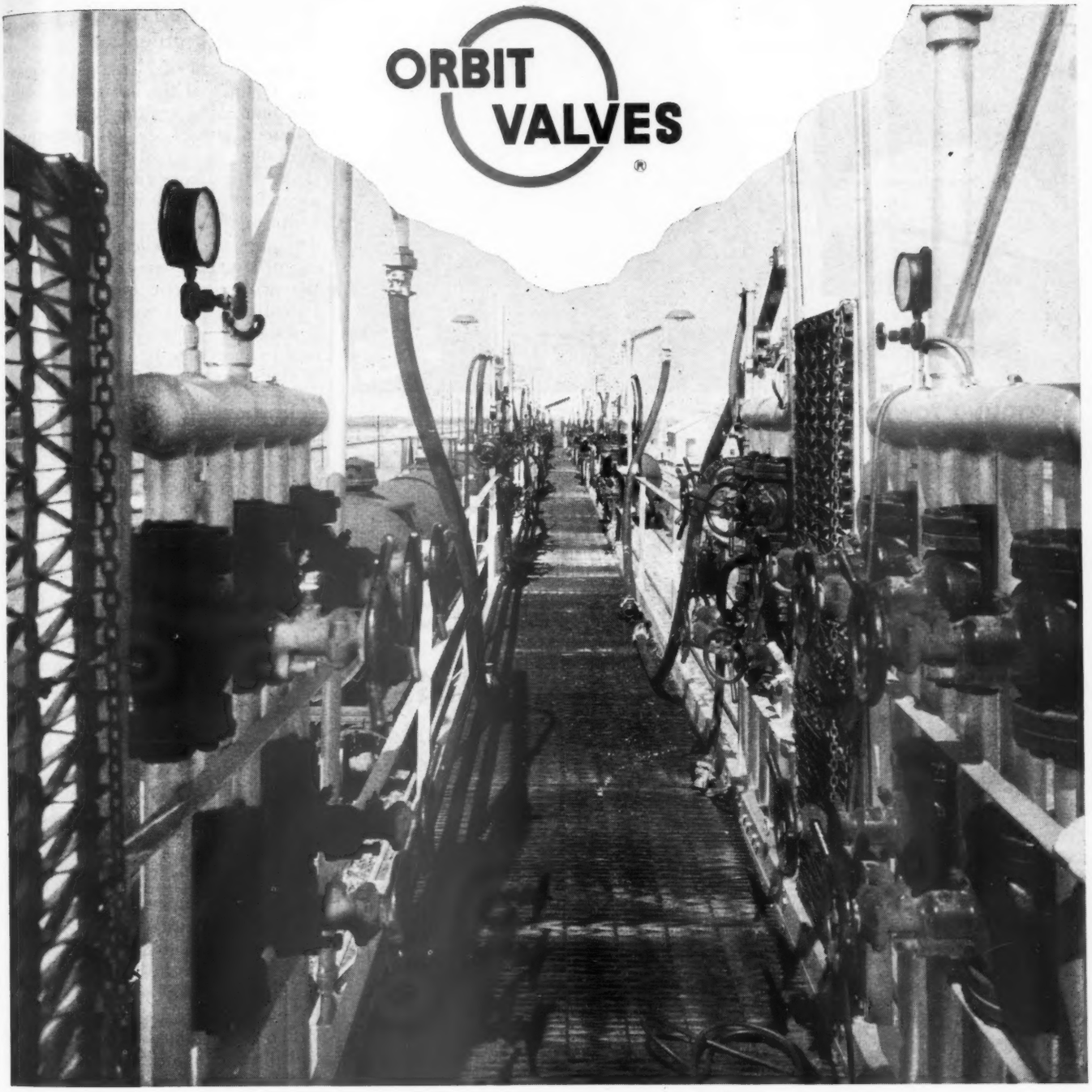
Now run a straight line through the two located points



in Columns A and B and the intersection with Column C gives the efficiency of the cooling tower or cooling device.

For example, the dotted line drawn across the chart shows that if the temperature of the water before cooling is 88 and the cooled water temperature is 82 the difference, 6, is located in Column A. If the wet bulb temperature of the entering air is 80, subtract from 88 and locate the 8 in Column B. The straight line then gives the efficiency of the cooling device as 75 per cent, in Column C.

During summer months one should expect an efficiency of 65 to 70 per cent. If an efficiency of 90 per cent is reached by your device that may be regarded as good. An efficiency of 35 per cent would be called poor. Much, of course, depends upon weather conditions. W. F. S.



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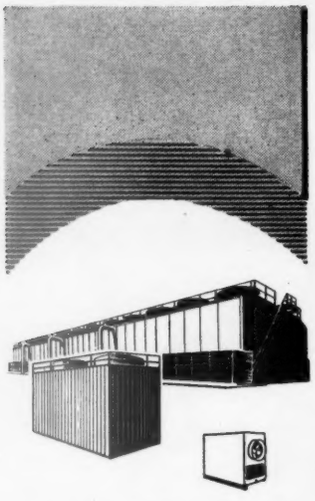
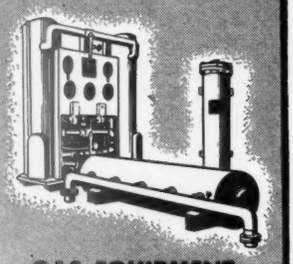
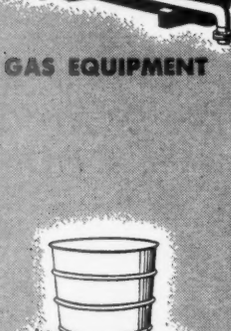


COOLING TOWERS



GAS EQUIPMENT



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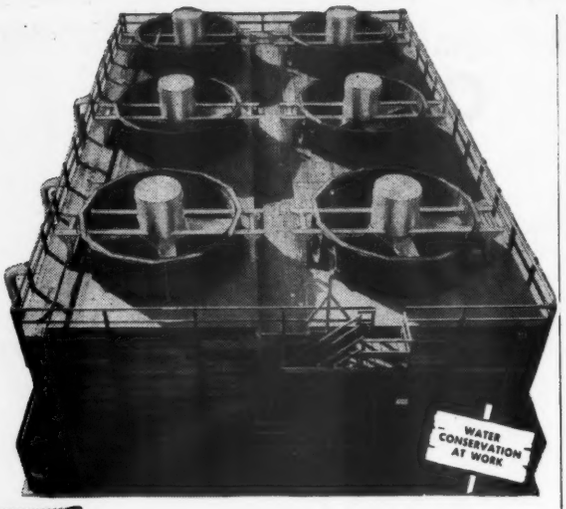

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B of M to Study Chemical Problems

The Bureau of Mines is undertaking a study of the current shortages and increasing requirements for benzene and phenol and other chemicals available in producing synthetic liquid fuels from coal and oil shale, according to James Boyd, director.

Major objective of the study is to determine the most desirable processes for producing chemicals in conjunction with synthetic fuels, Boyd said. Potential benefits would include (1) a new source of those chemicals either now in short supply or expected to be in time of emergency; (2) a supplementary source of aromatics or other special fuel components required by the armed forces; and (3) reduction of the cost of synthetic liquid fuels by the co-production and sale of chemicals.

The Bureau has appointed two consultants to assist in a general study of processes, yields, and markets. They are Dr. Gaston Du Bois of St. Louis, Missouri, formerly with Monsanto Chemical Company, and L. A. Schlueter of Washington, D. C., who is associated with the American Coke and Coal Chemicals Institute.

Phillips Develops New Carbon Black

A new carbon black developed by Phillips Petroleum Company research and now produced on a semi-commercial scale promises to give increased wear resistance to rubber and add more miles to tire life than obtainable from any available carbon black. it was announced by K. S. Adams. president of Phillips and of Phillips Chemical Company, its subsidiary.

Carbon black is an essential ingredient of rubber tires, imparting strength, toughness, and abrasion resistance. Actually, a tire rolls on millions of carbon black particles embedded in the rubber.

Called SAF black, the new carbon black, is produced from oil by a continuous process in equipment of unique design suitable for large-scale commercial plant operation. Samples are being distributed to the rubber industry for evaluation in laboratories and on the highways.

Becomes Chemistry Fellow

Robert C. Musa, Long Island, New York, has been awarded the $2000 fellowship established recently at Columbia University, New York, by the Socony-Vacuum Oil Company, Inc. He will work for a doctorate in surface chemistry. He is an alumnus of City College of New York and received his master's degree at Columbia last June.

Phillips to Operate Synthetic Rubber Plant

Phillips Chemical Company has been notified by Reconstruction Finance Corporation, Office of Rubber Reserve, that it will take over operation of the government-owned Copolymer synthetic rubber plant near Borger, Texas.

The transfer of operations to Phillips marks the first integrated manufacture of synthetic rubber through all stages from the production of raw materials to the finished product. Phillips Chemical Company already operates the adjoining Plains butadiene plant, which Phillips designed and built for the government during World War II. This plant now produces more than 50,000 tons of butadiene yearly. Butadiene is the principal raw ingredient of synthetic rubber.

Aramco To Use Sterling In Overseas Transactions

Negotiations between the British Government and the Arabian American Oil Company have opened the way for Aramco to utilize sterling in some of its overseas transactions, it was announced. Made at Aramco headquarters, the announcement stated that the oil company had been aided in its discussions by the United States Department of State. Companies that market Aramco oil are making arrangements to pay Aramco in sterling and other currencies. The talks with the British were for the purpose of adjusting exchange restrictions so that sterling received from the marketing companies could be used by Aramco for purchases of materials needed in Saudi Arabia and in royalty payments to the Saudi Arabian Government.

As a result of the talks in London, Aramco expects its production in Saudi Arabia to average about 490,000 bbl per day for the year 1950. It had been expected that the average during the year would amount to less than that figure, but utilization of sterling would enable Aramco's affiliated companies to retain markets that otherwise might have been lost.

Deep Rocks Completes Modernization Program

Major units of the multi-million dollar modernization program at Deep Rock Oil Corporation's Cushing refinery are virtually completed with the new cat cracker on full stream, W. J. Carthaus, vice president in charge of the company's manufacturing and research division, has revealed.

Begun in 1949, the new plants and equipment expected to be in full operation by autumn, will increase the Cushing refinery's daily crude capacity from 12,000 bbl to 18,000.

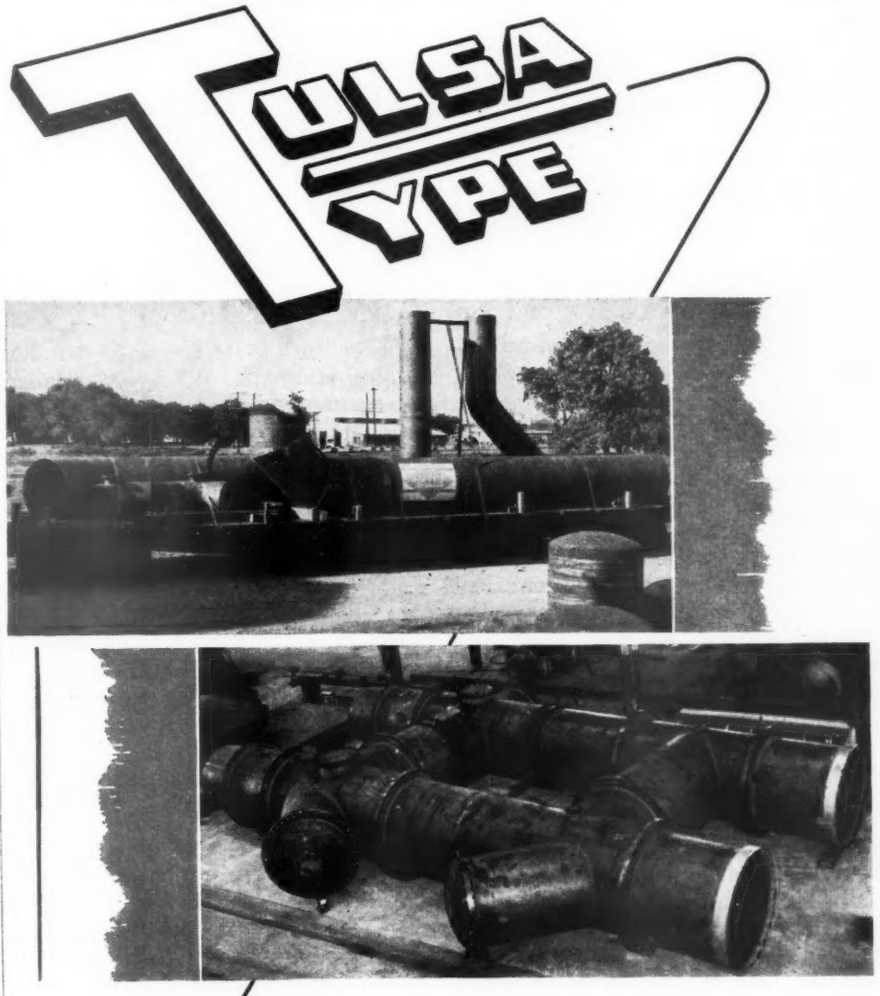
The building program included a crude oil topping unit, laboratories, office building addition, and auxiliary units.

Premier to Build Platformer

Premier Petroleum Company will build a Platforming unit at its Fort Worth, Texas, refinery, the first one in Texas. It will handle about 1500 bbl of fresh charge per day. Universal Oil Products Company, which developed the process and licenses it, will supervise design and construction.

Procon Will Construct UOP Units

Organization of Procon, Inc., with J. C. Raaen as president, to handle construction of UOP licensed refining units is announced by David W. Harris, president of Universal Oil Products Company. Headquarters of the new company are at 75 East Jackson Boulevard, Chicago. The new subsidiary will be occupied especially with the construction of units operating the new UOP Platforming process. C. B. Whyte is vice president and general manager; C. J. Giuliani, secretary and treasurer.



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—PERSONALS—

▸ **E. L. Sinclair** has been appointed assistant to R. R. Jackson, manager of Socony-Vacuum Oil Company, Inc.'s Paulsboro, New Jersey refinery. Sinclair joined the company in 1938, and was transferred to Paulsboro in 1949 from the company's refinery engineering department in New York. He is a University of Michigan graduate.

R. M. Chesney has been appointed operating superintendent of the Paulsboro refinery, where he joined Socony-Vacuum in 1932. He is a graduate of the University of Delaware.

T. C. Lockhart succeeded Chesney as assistant operating superintendent. A graduate of the Drexel Institute of Technology, Lockhart joined Socony-Vacuum in 1936.

J. L. Lawrence, graduate of the University of California, was named chief engineer to succeed E. H. Atwood, who retired after 38 years service with the company.

A graduate of Cornell University, Atwood was the first engineer employed by the Vacuum Oil Company, one of Socony-Vacuum's predecessor companies. He was co-inventor of a process for fractionating liquids, the fore-runner of modern refinery heat exchanges and holds other patents.

▸ **John R. Griffin** has joined the technical staff of the Du Pont Petroleum Chemicals Division as aviation consultant. He will specialize principally in fuel and lubrication problems in aviation.

Griffin is a graduate of the University of California. He came to Du Pont from the Sharples Corporation where he was chief engineer of the research laboratory.

▸ **R. C. Steinhoff** has been named assistant department head, thermal cracking, at the Texas City refinery of Pan American Refining Corporation. He succeeds **Frank K. Webb,** who was transferred to the personnel department as assistant director.

Brady V. Tunnell was recently transferred from assistant department head, catalytic and distillation, to assistant department head, light oil department; and **Lansing B. Robertson** was named process foreman of the chemicals plant. All men are stationed at the Texas City refinery.

▸ **A. J. Herron,** refinery manager and director of Bitumen and Oil Refineries (Australia), Ltd., has recently assumed the duties of manager of Caltex Refineries (Japan), Ltd., and consultant and advisor to the Japanese oil refiners who will process crude for Caltex Oil (Japan), Ltd.

Herron, who has been with The Texas Company and California Texas Oil Company, Ltd., for 30 years, returned from Australia last November as refinery manager and director of Bitumen and Oil Refineries. Prior to that he spent 18 months on Bahrein Island in the Persian Gulf as assistant superintendent of The Texas Company's West Dallas refinery.

▸ **Robert H. Bowden** has been transferred to the refinery-engineering division of Socony-Vacuum Oil Company, Inc., in New York. He was formerly supervisory process engineer at the Beaumont, Texas, refinery of Magnolia Petroleum Company.

▸ **C. L. Parris,** Standard Oil Company (Indiana), has joined Pan-Am Southern Corporation's El Dorado, Arkansas, refinery staff as chief engineer in the technical department under **Harry K. Wheeler,** technical director. A graduate of Texas Technological College and Illinois Institute of Technological Technology, Parris has been with Standard since 1942.

Robert O. Robertson, engineering-inspection department, Whiting, Indiana, refinery, has also joined the technical staff. He is a graduate of Iowa State College.

▸ **Robert E. T. McMahon** has recently joined the sales department of Jefferson Chemical Company, Inc. McMahon has just received the degree of Bachelor of Chemical Engineering from Clarkson College of Technology.

▸ **H. O. Evinger** has been named superintendent of Sun Oil Company's Sun field natural gasoline plant in Starr County, Texas. He formerly was superintendent of the Jameson Natural Gasoline Plant in Coke County, Texas, and is succeeded there by **John Shimer.**

Roy L. Cochran, formerly superintendent of the Sun Field plant, has been transferred to Brookhaven, Mississippi, for a special assignment.

▸ **Dr. H. Roswell Jones** has been appointed to Chemical Plants Division of Blaw-Knox Construction Company's synthetic fuels and chemicals department. He will be engaged mainly in the design of plants to produce finished refined products from Fischer-Tropsch, Oxo, and Oxyl syntheses.

▸ **David M. Boyd,** instrument engineer for Universal Oil Products Company, Chicago, was granted the degree of chemical engineer from the University of Colorado recently. This advanced professional degree was awarded to him for his development work on the graphic instrument panel and the paper he wrote, "Process Control by Graphic Panel."

Boyd is chairman of the production processes committee of the Instrument Society of America, and a member of the American Institute of Chemical Engineers and the American Chemical Society.

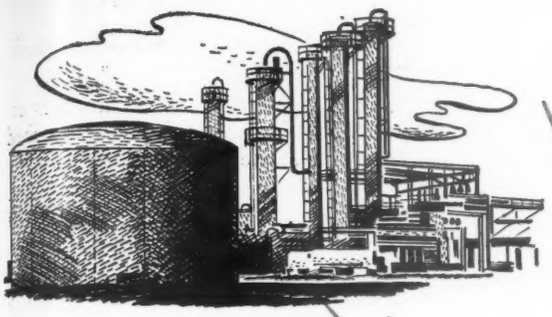
▸ **John M. Kindle** has been named to the post of superintendent of gasoline plants for Lone Star Gas Company of Dallas, Texas. The former assistant superintendent succeeds **Fred H. Townsend,** retired.

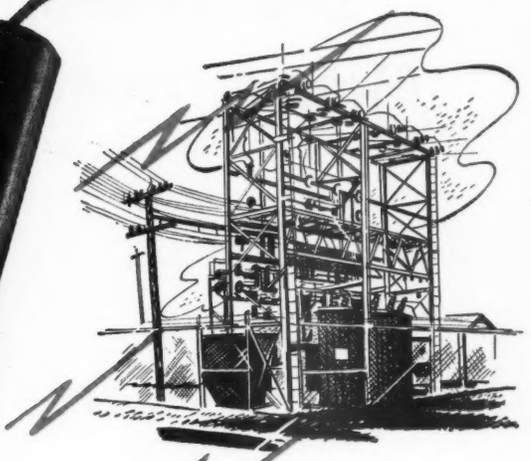
▸ **Dr. Rolston L. Bond,** technical director of the butadiene division of Cities Service Refining Corporation, Lake Charles, Louisiana, has been named assistant chairman of the chemistry and chemical engineering department at Armour Research Foundation of Illinois Institute of Technology.

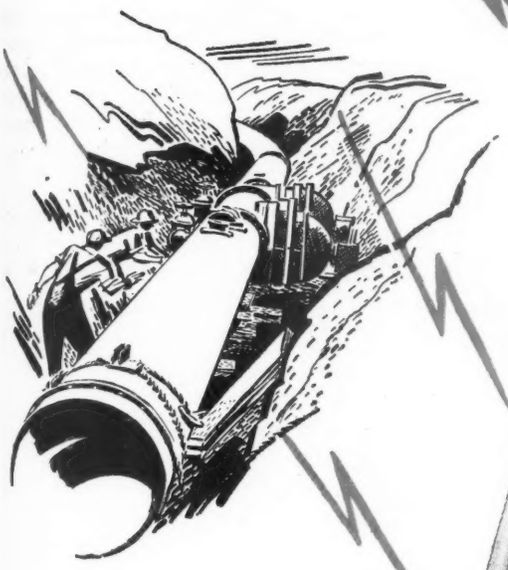
Bond will be in charge of the Foundation's biochemistry and organic chemistry research activities. An expert in petroleum technology, he has been with Cities Service since 1943. He was a research chemist for Tidewater Associated Oil and the National Oil Products from 1938 to 1943. Dr. Bond received his PhD degree from Pennsylvania State College in 1940.

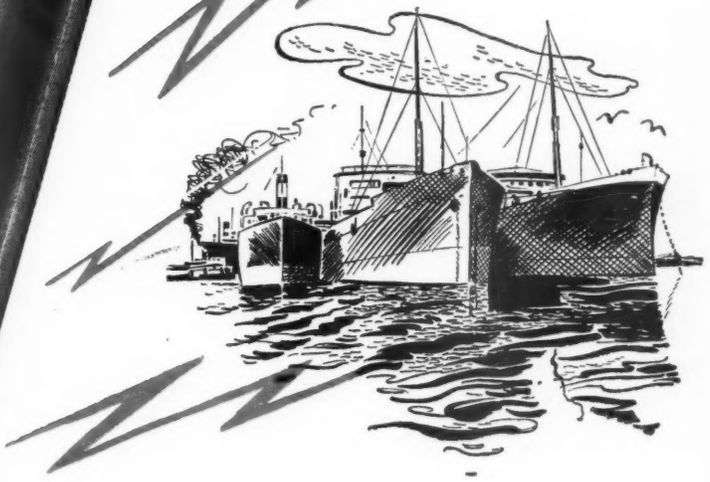
▸ **H. P. Caldwell** has been made supervisor of the refining section of the research and development laboratories, Socony-Vacuum Oil Company, Inc. Caldwell was employed by General Petroleum Corporation, a Socony-Vacuum affiliate, in 1934, after receiving his BS degree in chemical engineering from Purdue. He has been in the Socony-Vacuum laboratories, Paulsboro, New Jersey, since 1936.

▸ **Dr. Otto A. Beeck,** associate research director of Shell Development Company, California, and internationally known authority on physics, died suddenly of a heart attack July 5, in Emeryville, California. Dr. Beeck was born in Stettin, Germany, in 1904, had a part of his education in Europe, and later became an American citizen and finished his formal education at California Institute of Technology. He joined Shell in 1933, headed the physics department of Shell Development in 1936, and was made an associate director in 1942.









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LPG Production at Marcus Hook Refinery

H. F. THOMPSON*

To meet the ever increasing demand for liquefied petroleum gas in the North Atlantic seaboard area, Sinclair Refining Company, on March 1, placed on stream at its Marcus Hook refinery, a new unit with a capacity of 1100 bbl per stream day of liquefied propane gas. Construction of this unit, which was designed and built by Sinclair personnel, was begun July 1, 1949, and since going on stream last March, it has been operating continuously. Currently it is producing an extremely dry, low olefinic content LPG product, which meets all NGAA specifications for commercial propane.

Heretofore shipments of LPG to the Atlantic Coast were made from the Mid-Continent area, but this proved to be economically unsound due to high freight rates and delays in transportation. Hence it was decided that a source of supply nearer to points of consumption was necessary.

In this new plant the butanes and lighter hydrocarbons are recovered from cracked distillated stabilization operations and treated in sequence with diethanolamine and caustic solutions for the removal of hydrogen sulfide and mercaptans. This hydrocarbon stream is then subjected to a high pressure (1000 psig) catalytic polymerization operation wherein 85-90 per cent of the propylene-butylene content is reacted. The propane and lighter hydrocarbons stream from the polymer depropanizer are charged via gas-driven reciprocating compressors to a 20 tray deethanizer which fractionates out 85-90 per cent of the propylene-propane content of the charge for LPG sales. The composition of feed, overhead, and bottom streams of the deethanizer operations are shown in Table I.

TABLE I

	Feed Mol. %	Release gas Mol. %	LPG Liq. %
Methane	4.6	10.2	.....
Ethylene	4.7	10.5	.....
Ethane	29.9	65.5	0.5
Propylene	4.6	2.0	4.0
Propane	56.2	11.8	95.5
	100.0	100.0	100.0

A 126 ton per day capacity steam jet refrigeration unit is used during the warmer months of the year to provide 50 F cooling water for the reflux condenser of the deethanizer. A stuffing-boxless type centrifugal pump has given trouble-free operation in this rather difficult deethanizer reflux service. In order to prevent "frosting" of the overhead release gas pressure control valve and the downstream line from the same, an all welded shell and tube steam heater was installed between the gas outlet from the reflux accumulator and this gas release valve. LPG, the bottoms product of the deethanizer column, flows on level control from a cooler through an activated alumina drying tower and thence into 'bullet-type' storage vessels. Three such vessels of 600-bbl capacity each have been provided along with tank car and truck loading facilities.

Regeneration of the alumina is accomplished by stripping the adsorbed water from the drying beds with 3500 F propane vapors. A closed system is employed from the regeneration of the alumina beds and consists essentially of a propane accumulator, a small centrifugal circulating pump, a vaporizer in which 550 psig steam is used for vaporization and superheating and a water cooled exchanger to condense the propane and water vapor effluent from the drying bed. The water desorbed from the drying bed separates out in the accumulator and is withdrawn from a well at the bottom of the accumulator. The towers are currently on a 24-hr drying cycle with regeneration now being accomplished in 6-12 hr.

General design and current operations of this unit are as shown in flow diagram herewith. * * *

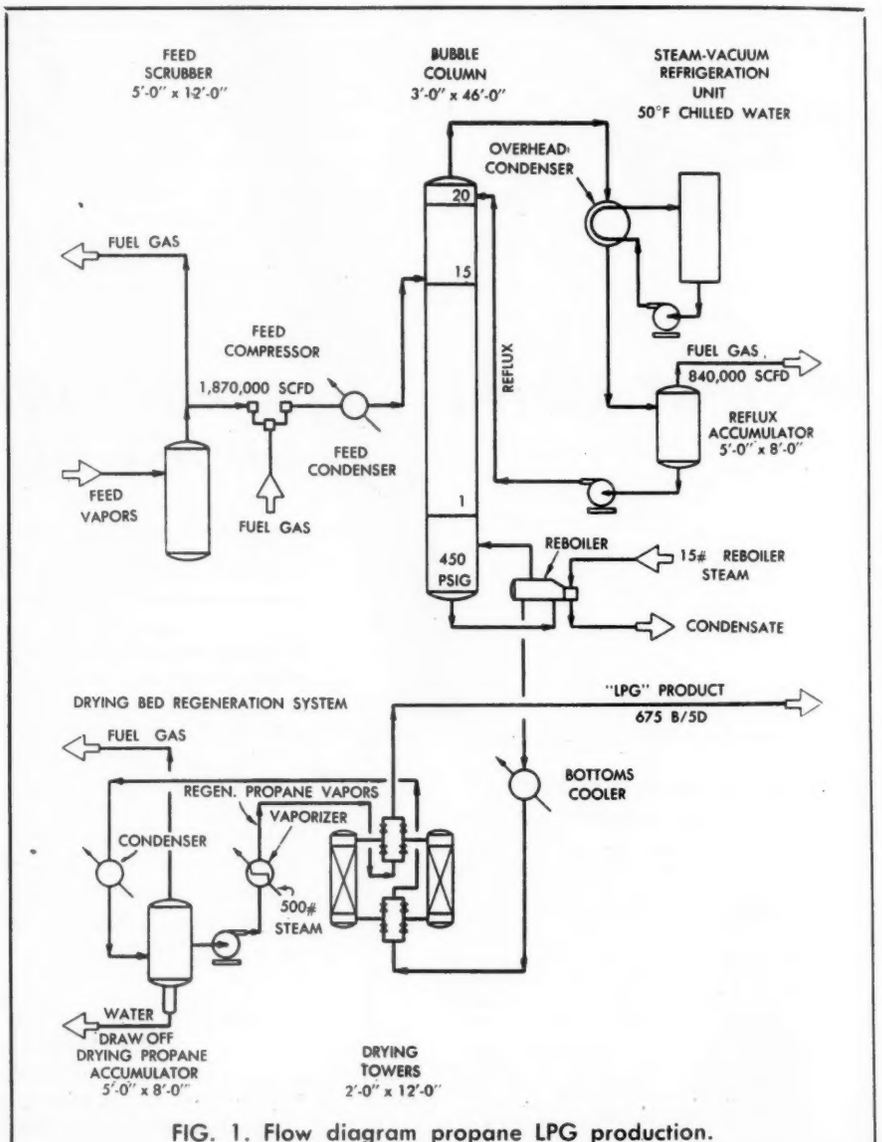

FIG. 1. Flow diagram propane LPG production.

*Chief, Technical Department Sinclair Refining Company, Marcus Hook Refinery.

Pipelining and Soil Conservation

THE pipe line industry has never been without progress since the day the first successful system for transportation of oil was constructed of cast iron back in 1865. Most of the progress has not been spectacular, but rather in the nature of steady development and, of course, has been principally mechanical. One major company, however, is doing something that does not come under the head of mechanics, but which we consider progressive, and because of its unusualness worthy of editorial comment. Reference is to Texas Gas Transmission Corporation's soil conservation program, a special article concerning which appears in this issue of *The Petroleum Engineer*.

Texas Gas began last fall a program of seeding the right-of-way after pipe was in the ground on its new system between Carthage, Texas, and Lebanon, Ohio—a right-of-way 50 ft wide and 820 miles long! The program, which was completed this year, was carried out primarily in the interest of preventing erosion to the land through which the pipe line passes.

The problem was approached scientifically. To head the conservation department of the company three men were selected, a chief and two assistants, men with practical experience in agriculture who would know how to go about the matter, because it wasn't a question of seeding just any cover crop. The purpose, in addition to preventing erosion, was to plant a forage crop most suitable to the various localities. Some are winter hardy, some are adapted to wet soils, others are acid tolerant, etc. To assure the proper plants being seeded, the farmers were consulted as well as farm agents and other agricultural specialists. Further, a booklet was prepared and distributed by Texas Gas to landowners explaining the program and what brought it about. But it doesn't stop there.

The booklet also tells ways in which the individual farmer may protect the soil on all parts of his farm, by contour farming and other practices, and increase his yields by practicing these and other tested conservation measures.

Several direct benefits to the gas company can be visualized as resulting from this program. A soil in good condition above a pipe line simplifies and reduces the cost of maintenance. Should leaks occur and damage crops, a sympathetic understanding on the part of the landowner is a virtual certainty. So it is good business. But, we think this program, which involved the expenditure of $225,000, was prompted primarily by a sincere desire on the part of Texas Gas officials to render an unselfish service to its many neighbors—the farmer.

J. H. Love

BIG NEW TEAM for LAYING BIG PIPE

"CATERPILLAR" OFFSET D8 TRACTOR WITH TRACKSON PIPELAYER

LOWERS THE BOOM ON CONSTRUCTION COSTS!

Big pipe goes down fast and easy when you handle it with this *big outfit,* especially designed to provide tremendous lifting capacity and accurate spotting control. That's why Bechtel, Price, Conyes Corp., Needles, Calif., chose it for laying this 34" high-pressure gas line, the largest in the world. Working the stretch from Topock, Arizona, to Milpitas, Calif., the new "Caterpillar" Offset D8 Tractor with new Trackson Pipelayer averages 9000 feet per 10-hour day. The pipe is 7/16" thick and weighs 192 lbs. per ft. In all, there are 23 "Caterpillar" Diesel Tractors on the operation—and they're paying off with schedule-keeping performance.

Got a big job to figure? You can count on this *big outfit* to make good for you. Rugged and reliable, it's the answer to your problem of handling big pipe profitably. Get the facts today about the Offset D8 from your nearby "Caterpillar" dealer.

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1. ***Extended track frame*** on the trench side provides maximum leverage.
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3. ***Hydraulically controlled counterweight (10,000 lbs.)*** gives the balance needed for handling big pipe. When working tight places, it can be quickly retracted.
4. ***Greater lifting capacity,*** for example:

Overhang	4'	6'	8'	10'	12'	15'	18'
Capacity, lbs.	83,600	55,500	41,500	33,000	27,400	21,800	18,000

5. ***Proper boom and hook speeds*** provide better control, facilitate accurate spotting of heavy pipe. The Offset D8 also has improved, increased-capacity drum braking for instant control.

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PIPELINE OFFICIALS GATHER TO SEE REVOLUTIONARY NEW ANGLE GAS ENGINE COMPRESSOR

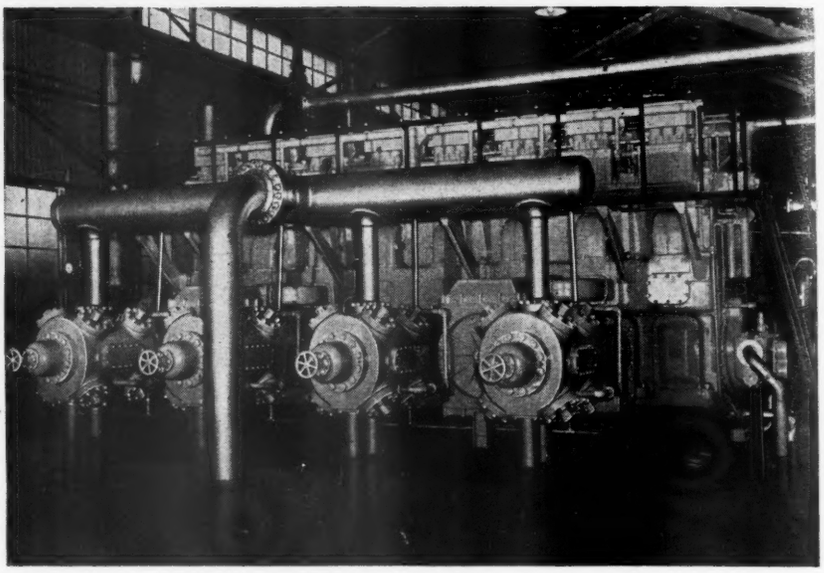
Tennessee Gas Transmission Company's New Worthington Uniflo TYPE UTC-16 Draws Visitors From Near And Far

So widespread was the interest in Worthington's new Angle Gas Engine Compressor, TYPE UTC-16, that engineers and other executives from transmission companies all over the country came to see the first of these units in actual service — at the Tennessee Gas Transmission Company's Monroe, La., plant.

Advance notices of outstanding performance were fully lived up to, observers being particularly enthusiastic over the new uniflo scavenging. This radical improvement over conventional loop design provides more than double the port area and 50% more exhaust area. Straight-line air flow thoroughly cleanses and cools the entire cylinder, and timed valves retain greater weight of pure air for perfect combustion and stepped-up supercharging.

Features For Top Performance

En bloc frame, with removable cylinder liners . . . double air manifolds . . . completely symmetrical outer piston walls, wrist-pin in separate carrier . . . cone-type cylinder head, with streamlined passages and two large exhaust valves gear driven camshafts for positive drive and perfect timing . . positive pressure lubrication through cast-in manifolds to all moving parts . . . large access doors on both sides of frame for complete accessibility . . . Worthington Feather* Valves, most efficient ever made, in all cylinders.



The Tennessee Gas Transmission Company's new Worthington Angle Gas Engine Compressor — uniflo TYPE UTC-16 — installed at Monroe, La. The Company's natural gas pipeline will reach Buffalo, N. Y., and further extension is planned.

Wide Usefulness

On pipeline duty, in refinery service— in fact, wherever gas must be compressed and suitable gas fuel is available — the uniflo TYPE UTC-16 offers dependability and economy never before possible . . . proof that, as always, *there's more worth in Worthington.* Learn more about this outstanding advancement in angle gas engine compressors Contact your nearest Worthington Branch Office or the *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

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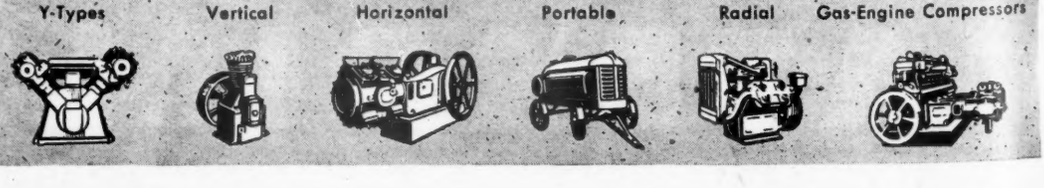
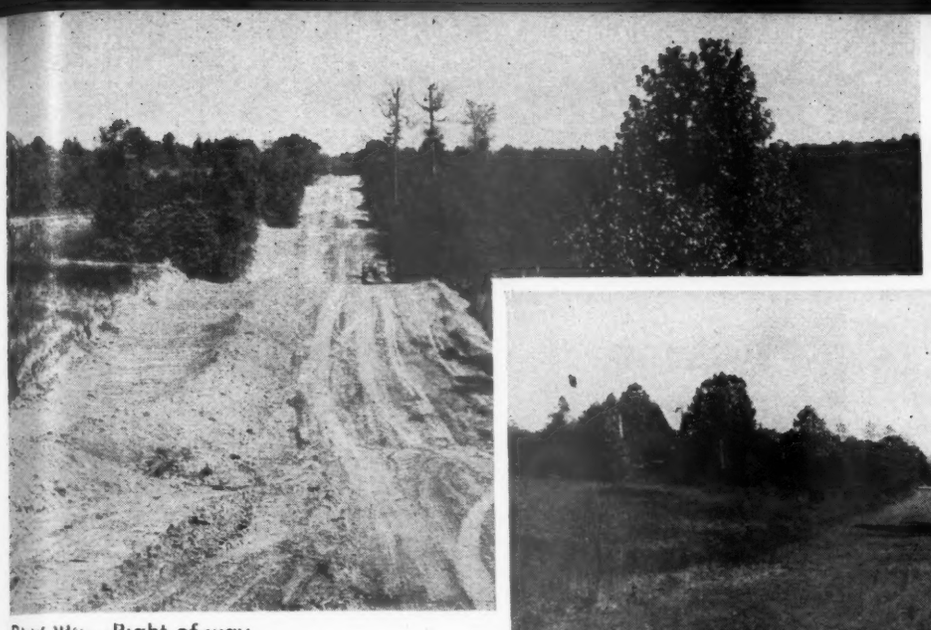




BEFORE—Right-of-way immediately after backfilling.

AFTER—Cover crop has made a good start.

Pipe Line Company Aids Soil Conservation

Texas Gas Transmission Corporation Believes It Is Good Business To Terrace and Seed Right-of-Way After Pipe Line Is In Ground.

FRANK H. LOVE*

ON first thought soil conservation and pipelining may not seem, in any manner, to be related subjects. Texas Gas Transmission Corporation of Owensboro, Kentucky, however, is making soil conservation an important part of its program, the first time a major, or minor for that matter, pipe line company has considered this phase of pipelining important enough to do something about on a large scale.

Even before its 800-mile Texas-to-Ohio line was completed last fall, the company had organized a conservation department headed by experienced agriculturists to aid and encourage soil conservation on land above and adjacent to the company's pipe lines. The objective was to seed a right-of-way 50 ft wide and 800 miles long for the dual purpose of preventing erosion and providing a forage crop for stock. Last fall the several crews covered as much ground as they could before winter set in, and this spring continued the work.

At the outset the company budgeted $225,000 to defray the cost of the work, which covered labor, seed, fertilizer, and equipment. Eight crews were put in the field last fall, each crew seeding an average of a mile a day. The crews were placed about 75 miles apart and each assigned 400 to 500 acres to seed.

Cooperation of the individual farmer was an essential part of the program. So, well in advance of beginning work each landowner was contacted and advised of the company's plans and his permission obtained to carry them out. Whether a permanent pasture was seeded or a temporary winter cover depended on the farmer's own plan for the land involved. If he intended to put it back in crop rotation a temporary seeding was advised. If the land was to remain in permanent pasture an excellent permanent pasture was seeded. Both mixtures, temporary and permanent, were properly fertilized. In fact, the choice of seed and fertilizer for each locality was determined only after consultation with county agriculture agents, vocational agriculture teachers, soil conservation personnel, and farmers in the area. In this manner, the proper kind of vegetation was assured for the locality in which it was planted. Some plants were chosen for their winter hardiness, some for their soil holding quality, others because of their nutrient value as forage for livestock. Some were adapted to wet lands, most were acid tolerant, and all were excellent pasture grasses.

In addition, when necessary a winter small grain was sown with the

*Oil and Gas Pipelining Editor.

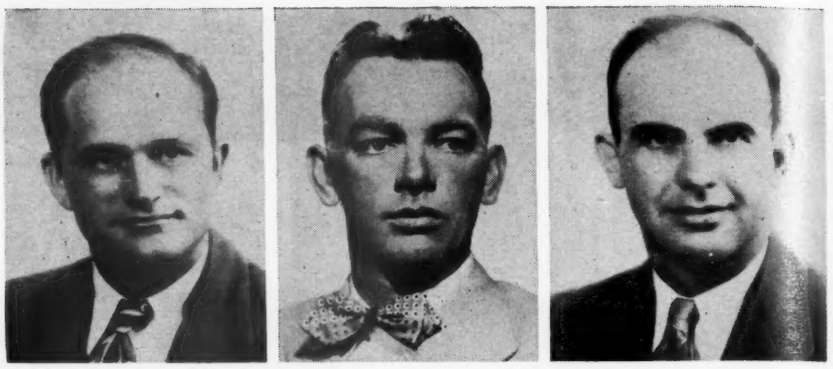
EXCLUSIVE

grass mixtures. In the spring, legumes were added. Grasses and legumes were sown only on the permanent sod fields. Small grains and winter legumes were used for temporary winter cover on fields plowed and cultivated the year before.

As mentioned, success of the program required the complete cooperation of the landowner. For example, if tender seedlings were grazed before they became well established they would fail. Small grains should be from 8 to 10 in. high; when grazed down to about 6 in. stock should be removed. If grazed continuously the seeding will be a failure. Such things were pointed out to the land owner both by word of mouth and by published literature made available to all farmers along the pipe line company's route.

The company did not stop with consideration only of the pipe line right-of-way, however. In a sincere effort to help the farmer with all his erosion problems, a program of education is being sponsored to show him what methods he can follow independently to conserve his land and increase its yields. He is shown how his yields and profits are increased by the use of terraces, diversion ditches, contour cultivation, and strip cropping where necessary. He is shown how his livestock returns are increased by proper land use, the establishment of improved pastures, and the renovation of old pastures.

Trained agriculturists head up Texas Gas' soil conservation program. J. W. Carneal, chief of the department, was born and reared on a farm, studied agriculture in high school, and was graduated from Murray State College, Murray, Kentucky, in 1940 with a BS degree in agriculture. In 1946 and 1947, he did graduate work in soils at the University of Kentucky.



These trained agriculturists are in charge of the Texas Gas conservation program. They are chief conservationist, J. William Carneal (left), Maurice E. Bless, and Aaron H. Griffin.

For two years he was a partner and supervisor with Enlow, Brewer and Company, farm contractors. For two and a half years he taught agriculture to veterans engaged in "On the Farm Training Programs," and subsequently was agricultural training officer for the Veterans Administration at Louisville.

Maurice E. Bless, one of Carneal's two assistants, also was born and reared on a farm. He studied agriculture in high school and was graduated from the University of Kentucky in 1947 with a BS degree in agriculture. He did graduate work in soils at the University of Kentucky and for four years taught vocational agriculture in high schools.

Aaron H. Griffin, the other assistant, was born and reared on a western Kentucky farm and graduated from Western State College at Bowling Green, Kentucky, with a BS degree in agriculture. He did graduate work at the University of Kentucky and served three years with the Farm Security Administration, 2 yr as a vocational agriculture teacher in high school, and two years as district agriculture supervisor for the Veterans Administration at Louisville.

The staff working under these supervisors consisted of 50 pipe line department employees. Each crew was provided with modern machinery and equipment, consisting of a flat bed truck for hauling seed, a tractor, grain drill, disc harrow, cultipacker, and terracing blade scoop.

Management of Texas Gas Transmission Corporation considers this a program, of real value, one that is worth every cent of the $225,000 expenditure, of course, or it wouldn't have approved it in the first place. Says W. T. Stevenson, executive vice president, in addressing himself to the landowners:

"We share with you a mutual interest in conserving the soil. You may ask why a pipe line company should want to help you with soil conservation after the pipe is in the ground. Texas Gas knows that the land above its lines should be kept in good condition to protect a valuable property from damage from the elements. We feel that the best way to do this is to help the farmer who is also concerned with the up-keep and value of his acreage. If we can help you to conserve soil and increase yields on the section of your farm through which our pipe line runs, we make our job of inspection and maintenance a bit easier. We are also doing something to gain a friend. Perhaps this is the real reason."

How do the farmers through whose land the pipe line runs feel about the matter? Their feeling is perhaps best summed up in the words of a farmer living near Hardinsburg, Kentucky, who said: "Texas Gas has certainly done a fine job of restoring my land by terracing and seeding with a year-round cover crop to prevent erosion."

Thus, the program would seem to be a two-way proposition—beneficial both to the farmer and to the operating gas company. * * *

Each crew was equipped with a flat bed truck for hauling seed, a tractor, grain drill, disc harrow, cultipacker, and terracing blade scoop.

Construction crews pictured near Boise, Idaho, are rapidly completing a 566-mile oil products pipe line being built from Salt Lake City to Pasco, Washington, on the Columbia River.

Radioactive Tracers Used In Products Pipe Line

A. P. HOWELL* and R. K. BOND*

SALT LAKE PIPE LINE COMPANY, a subsidiary of Standard Oil Company of California, is constructing a products pipe line from Salt Lake City, Utah, to Pasco, Washington—a distance of 566 miles. The line is now in operation to Boise, Idaho, and will be completed to Pasco in the early fall of 1950. It is a common carrier pipe line available for transportation of products from the Salt Lake City area to certain points in Utah, Idaho, eastern Oregon, and eastern Washington.

It is expected that products of several different types and grades will be transported. Under the Salt Lake Pipe Line Company's tariff, these will be shipped as individual stocks rather than on the "common stock" basis used by some products carriers.

One of the most interesting operating features of the line is a new method developed for following the "interfaces" (boundaries) between products moving through it. This method uses very minute quantities of a radioactive isotope tracer injected into the line each time a product is changed. Sensitive Geiger counters, coupled to recording instruments, detect and record the passage of radioactivity in the interfaces at various points along the line. From this record the operators can both identify interfaces as they pass and keep the products properly separated as they are delivered to tankage. The details of this operation and the precautions taken to insure completely safe operation are given in the following paragraphs.

*Standard Oil Company of California, Engineering Department.

Identifying Interfaces

The need of identifying interfaces in product pipe lines is not new, and the many lines now operating use a number of methods, including gravitometers, colored die plugs, hand samples, and careful dispatching. None of these common methods appeared either accurate or convenient enough for the Salt Lake Pipe Line, principally because of the following complicating factors:

1. The relatively small amounts of individual product taken off at any one point, as compared with larger products lines elsewhere in the country.

2. The many take-off points (seven) and a terminal at which products are distributed.

3. The length of the line—566 miles.

4. The many different products pumped through the line, including several different types and grades of gasoline, diesel oil, and stove oil that must be identified and delivered at various points.

For these reasons, it was desired to develop a new method of marking product interfaces. This method would need to be independent of the physical properties of the products and give a clear and reliable indication of both the location of an interface and the extent to which the adjacent products had commingled with each other. These requirements could best be met by a "tracer" employing a radioactive isotope. In order to verify that the method would work, California Research Corporation and the engineering department of Standard Oil Company of California undertook an extensive development program. The first step in the program was to explore the spread of a radioactive tracer solution in a relatively short section of pipe line. After these results were studied, full-scale tests were made on a 180-mile crude pipe line from Rangely, Colorado, to Salt Lake City. It was found that the tracer traveled through the line with the oil and that it spread in close agreement with the anticipated diffusion between two adjacent products flowing through the line. It was easily possible to detect the radioactivity of the greatly diluted tracer liquid when it arrived at the terminal of the line. The California Research Corporation laboratories then investigated radioactive isotopes and developed a compound of radioactive antimony as the most suitable for routine use. Finally, a test injection was made in a California products pipe line to confirm the suitability of this tracer compound.

Methods and Equipment

Isotope preparation. The first step is preparation of the tracer compound in the Richmond laboratories of California Research Corporation. For this purpose ordinary non-radioactive antimony is used. The material is then sent to the laboratories of the U. S. Atomic Energy Commission at Oak

Ridge, Tennessee, where it is placed in an atomic pile and subjected to neutron bombardment for the necessary period. In this process some of the stable antimony is converted to a radioactive form. The compound itself is to all appearances the same, but it now gives off the penetrating rays that are the basis for its use as a tracer.

This "hot" material is returned in a lead-shielded box to the California Research Corporation laboratories, where it is further processed and diluted with light oil to become the tracer liquid. This liquid is shipped to Salt Lake in a stainless steel vessel enclosed in a heavy cast-steel shipping container that serves both as carrying case and shield.

Injection apparatus. At the Salt Lake pump station the tracer liquid sent from the Richmond laboratory is stored in a stainless steel vessel behind heavy lead shielding. The injection system itself was carefully designed to permit handling the radioactive liquid with complete safety to the operators. All operations are by remote control, with valve handwheels extending bevond the shielding. Mirrors are used for observation of the tracer liquid when the injection quantity is measured in a gage glass. This is the only place in the entire installation outside of the laboratory where the radiation levels are sufficiently high to require precautionary measures.

Each time the product pumped through the line is changed, a few cubic centimeters of the tracer liquid are metered out and injected into the pipe line just at the interface. The tracer then follows the interface through the line and can be easily detected with suitable instruments.

Instrumentation. Conventional laboratory instruments redesigned for industrial use were installed at stations along the line to measure the radiation in the interfaces. At each station several Geiger-Mueller counting tubes and a pre-amplifier are strapped to the pipe to detect the passage of radioactive material in the oil stream. The outputs from these tubes are fed into a specially designed counting rate meter, which is connected to an appropriate recorder.

The Geiger-Mueller tubes and rate meter are continuously reading the "background" of the natural cosmic radiation that is always present. This background count is suppressed in the recording instruments, so that a record is made only of the additional radiation picked up when the interface passes the instrument. The recorders are of the strip-chart type and are so calibrated that the curve trace extends nearly the full width of the chart at the peak of radiation intensity corresponding to the center of the interface.

Instruments were installed at the Salt Lake pump station, where a single recorder provides a record of each injection and indicates approximately the amount of radioactive material used each time. At points where only product "heart-cuts" are to be taken out, one set of instruments was installed, with the tubes on the pipe at the incoming manifold. At the terminal and other points where the full stream is taken, the usual equipment was installed and, in addition, provision was made to telemeter the arrival of the interface from a point out on the line. This is accomplished by a second set of tubes and a counting rate meter located upstream of the station at a distance greater than the total width of the interface anticipated. Near the end of the line this distance is as great as 7 miles. The output of this rate meter is telemetered by wire or FM radio to a second recorder at the station.

Method of Operation

Use of tracers for controlling product movements. With the instrumentation described, it is possible to identify accurately the passage of the interface at each take-off point along the line. The pipe line dispatcher maintains close control over the position of all the products in the line from the records of interface passage reported to him by the operators at the various take-off points. With the information available to him, he need not predict the exact time of arrival of each interface at each station. Also, the station operator need not waste hundreds of hours a year standing by to "catch" the interface passage with a gravitometer when the cut is to be made in an interface. The recorded trace of interface radioactivity at each station always indicates the locations of the products in each section.

At take-off points where only a heart-cut is to be taken from the moving stream, the operator need only verify from the tracer chart that the interface has passed. Then, in accordance with instructions from the dispatcher, he will withdraw the required amount of that product to tankage.

At the terminal and at other points where it is necessary to take the entire stream, including an interface, the problem of separating the two products becomes more complicated. It is for this reason that advance telemetering of the interface is used at such locations. The record transmitted from the upstream counting rate meter provides a warning of the approaching interface and gives the operator the peak counting rate corresponding to the center of the interface. With this information, using the recorder at the manifold, the operator can "cut" the product at some predetermined percentage of the peak counting rate corresponding to the most desirable blending of each product. If it is necessary to take a "slop cut" in order to maintain product specifications, this can be done with a minimum loss of product and with better knowledge of the exact composition of the "slop."

Radiological Safety

The only point on the pipe line where special precautions are necessary to assure the safety of the operating personnel is the Salt Lake station where the tracer liquid in its concentrated form has a high radiation level. The precautions taken with the injection equipment have already been described. The injection installation is so designed that the radiation level at the surface of the enclosure is well below the amount established as safe by the National Committee on Radiation Protection.

One important point should be emphasized: No appreciable amount of radio-activity remains in the products whose interfaces have been traced with the isotope. This is true for the following reasons:

1. The tracer is immediately diluted when it is injected into the pipe line.
2. The products are stored in tankage and their radioactivity further diluted.
3. An unbelievably small amount of radioactivity is required for detection by the extremely sensitive instruments used. For example, the radiation level at the peak of the interface when the product is on its way through the line is less than that of a common luminous wrist watch dial.
4. As a further safeguard, the isotope by its nature is self-destroying; that is, its radioactivity decreases with age. This was an important point in the selection of this compound.

Along the pipe line, of course, the liquid tracer has been so diluted that no possible hazard exists and no special operating procedures or precautions are needed.

Conclusion

This application of a new scientific development represents a distinct advance in the control of product pipe line movements. It is the subject of patent applications by California Research Corporation. * * *

Gas Heat Exchangers as Applied to Transmission System Problems*

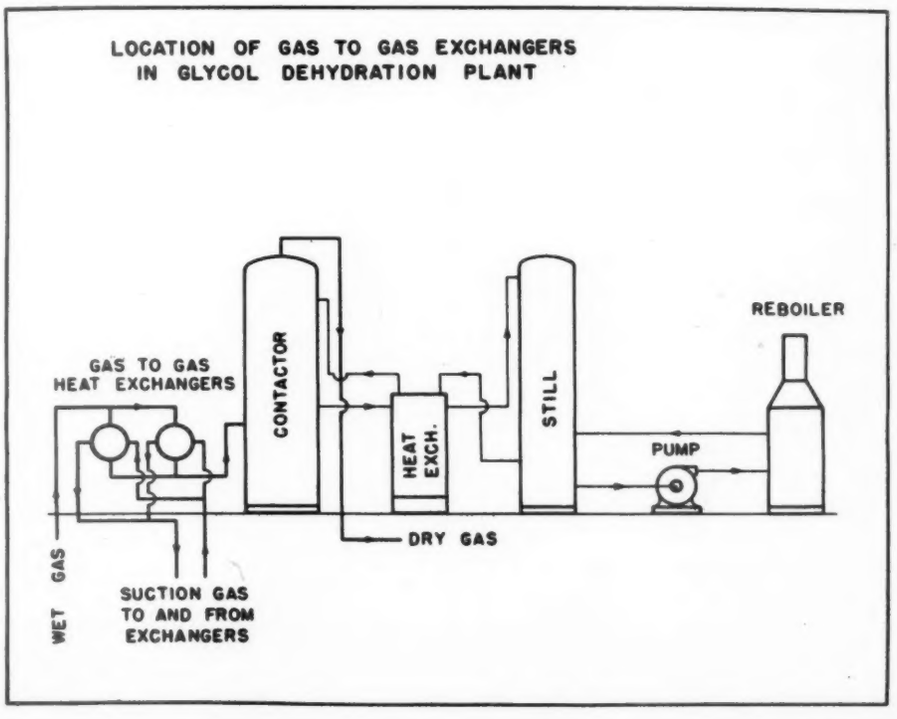
F. S. YOUNG†

THE transmission of large quantities of natural gas through a cross-country pipe line system is an undertaking that inherently involves vast power requirements, and, as there is no way of obtaining this power with perfect thermal efficiency, the process must necessarily include satisfactory means for dissipating and rejecting the waste heat given off from the system. This waste heat appears in many forms, some of which present no difficult problems of disposal, and others require rather expensive equipment for their dissipation. The scope of this discussion is not intended to include the recovery of useful work from these heat sources, rather it is to deal with economical means of handling some of those heat loads that do not lend themselves to practical recovery methods.

The primary consideration in the study of a cooling problem is this: Ultimately, the heat load involved must be rejected to one of the two large natural reservoirs, the earth or the atmosphere. The problem then resolves itself to finding the most practical way of accomplishing this end result, bearing in mind the basic factors of economy and dependability. Following this line of reasoning, it is apparent that the introduction of an intermediate stream of some cooling medium between the heat source and the heat sink, whereas often necessary and unavoidable, is nevertheless the first step in complicating the problem. When these cooling streams are compounded, as, for instance, in the case of engine oil cooling, the problem becomes correspondingly more complicated and involves more equipment. Considering the example just mentioned, the oil receives heat from the engine and transfers this heat to a water stream in the conventional type oil cooler. The water stream may then carry the heat to a cooling tower where another transfer occurs between water streams, and the waste heat is finally rejected to the atmosphere in the upper part of the tower. The basic transfer of heat from the engine to the atmosphere has been achieved by means of three intermediate cooling mediums. As the great majority of practical cooling problems involve one or more of these "connecting links" between the source and the point of rejection, it is easy at times to overlook the fundamental process. Thus, toward the end of simplification and reduction of the equipment required, the design engineer should, in general, attempt to find the most direct practical means of disposing of the heat. Therefore, when the temperature level is high enough, the possibility of direct air cooling must always be considered. Similarly, when a small heat load is encountered at a moderate temperature level, there is the possibility that this heat can be absorbed economically by a cool suction gas stream. Unless the distance between stations in a transmission system is unusually short, the pipe line, in itself an immense gas-to-earth heat exchanger, maintains the gas on the suction side of a station at or near the prevailing ground temperature, and so long as the gas temperature is not increased enough to affect materially the horsepower requirements of the station, the relatively low temperature gas stream can be used as a receiver for some heat loads. This paper will deal primarily with such applications of gas cooling and will attempt to evaluate, by comparison and analysis, the advantages obtained.

When considering the feasibility of gas as a cooling medium, certain advantageous applications become apparent, as do certain limitations that must be recognized. At stations where water is scarce—particularly in the case of those stations without gas aftercooling—the suction gas stream is well suited as an absorbent for some of the smaller station heat loads such as oil cooling; in fact, in such locations, suction gas oil cooling has been successfully incorporated with air-cooled jacket water systems to the end that open water cooling equipment with its accompanying water makeup problem has been completely eliminated. Also, in the case of automatic desulphurization plants situated at the wellhead, the gas stream can be used to cool the still overhead, again eliminating the need for water cooling and

FIG. 1



*Presented at NGAA Amarillo-Plains regional meeting.

†Ass't Chief Engineer, Panhandle Eastern Pipe Line Co., Kansas City, Mo.

pumping power.

Of course, under some arrangements, the use of gas cooling serves merely to transfer a heat load from one service or one stream to another. When the discharge gas from a station is cooled before leaving the station, the heat picked up by the gas in a suction gas oil cooler is added to the aftercooling load and finally dissipated in the gas aftercooler. This trading and collecting of heat quantities can often be used to advantage in simplifying piping layouts and equipment requirements. Also, in the case of a glycol dehydration plant situated on the discharge side of a compressor station, a very definite advantage is obtained by installing a gas-to-gas heat exchanger upstream of the plant, thus effectively lowering the contact temperature and the dew point obtained. In such an installation, it is possible to lower the temperature of the discharge gas well below the temperature ordinarily attained in a cooling tower. As has been pointed out, the heat is merely transferred to another stream, but the lower temperature level is being utilized to obtain better dehydration. A more detailed analysis of this arrangement will be given later.

As to the general performance of gas exchangers, very satisfactory results have been experienced with such equipment now in use. Maintenance costs have been low and very little fouling has been encountered. Close agreement with design figures in all such installations has been obtained by checking field data.

The two most common forms of gas heat exchangers in use on the Panhandle Eastern System are the suction gas oil cooler and the gas-to-gas exchanger for dehydration plants. Both these types have been mentioned earlier, but it might be of interest to study them more intensively. Each has proved itself in operation and merits some analysis as to its effect.

Gas-to-Gas Exchanger

First, let us study the gas-to-gas exchanger serving a glycol dehydration plant. This was the earliest application of gas cooling on the Panhandle System. Fig. 1 shows the location of such an exchanger in a simplified plant flow sheet.

Gas from the field passes through the shell side of the exchangers and absorbs heat from the discharge gas. The discharge gas passing through the tubes is correspondingly cooled by this transfer and enters the contactors at a lower temperature. The advantage of having the contact process occur at a lower temperature is, of course, obvious. Fig. 2 shows the effect of contact temperature on the equilibrium dew point for various concentrations of glycol solution. Assuming that the plant operates with a 95 per cent solution to the contact towers, this chart can be replotted as shown in Fig. 3. Now, the dehydration of gas is largely of interest during the months of November through April. Without gas-to-gas exchangers, a plant might receive wet gas at about 85 F during these months. This would be a fair figure based on the operation of an atmospheric cooling tower aftercooling the gas from the compressors. From the chart (Fig. 3), the equilibrium dew point corresponding to 85 F is 37 F. With gas-to-gas exchangers, the contact temperature might easily be lowered to 70 F, which corresponds to a dew point of 24 F. Also, the exchangers serve to "iron out" the fluctuating diurnal temperature of the gas from a cooling tower, a commonly experienced phenomenon that is particularly

FIG. 2

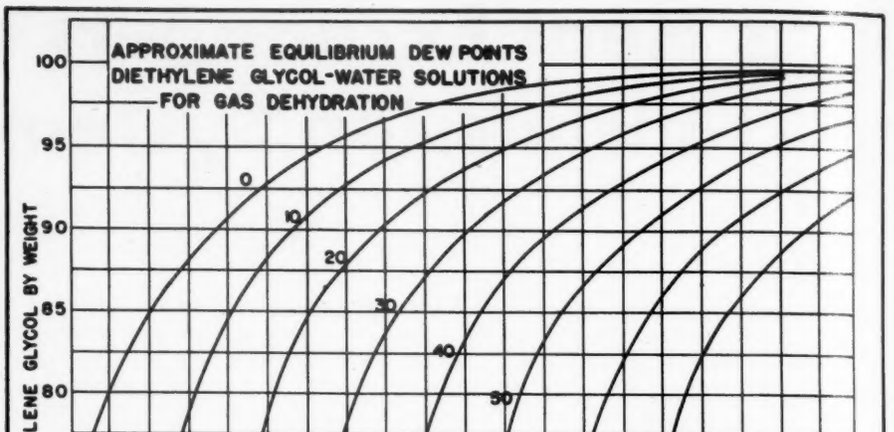
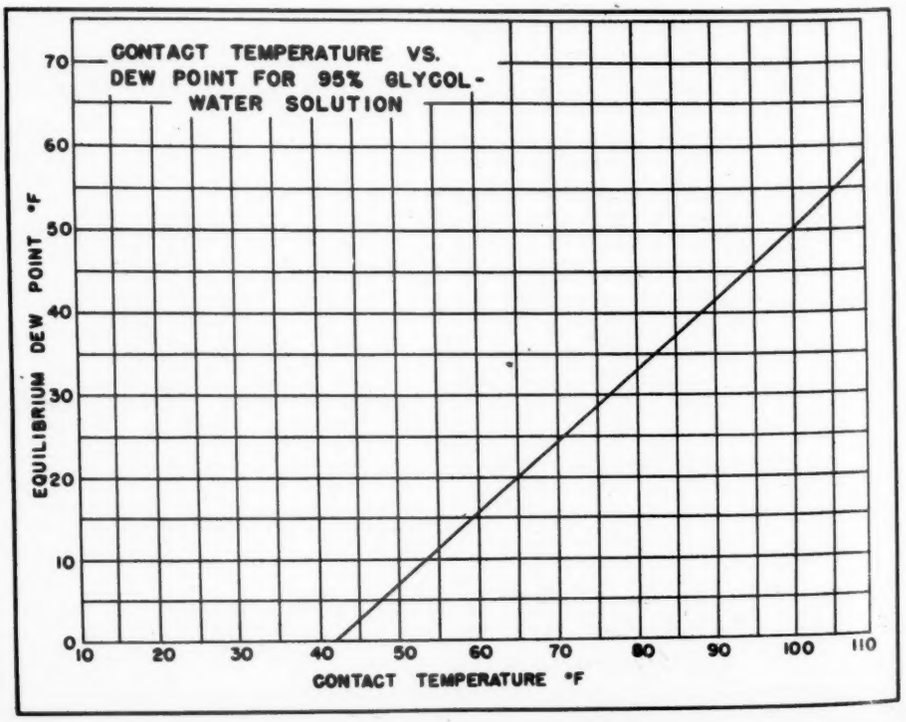


FIG. 3



troublesome during winter days when proper dehydration is critical. Notice, too, that the colder suction gas, the temperature of which follows the ground temperature exactly, gives the best cooling and the lowest contact temperature precisely when it is needed. The overall process is largely relieved of the effects of daily weather and temperature changes, and gives dew point performance that is in keeping with the seasonal ground temperature condition. This is a very important advantage.

In the summer months, when hydrate formation is less likely to occur, the gas exchangers may be bypassed to prevent an unnecessary increase in the suction temperature; or, for that matter, it is likely that conditions might be such that the plant operator could shut down the dehydration unit completely.

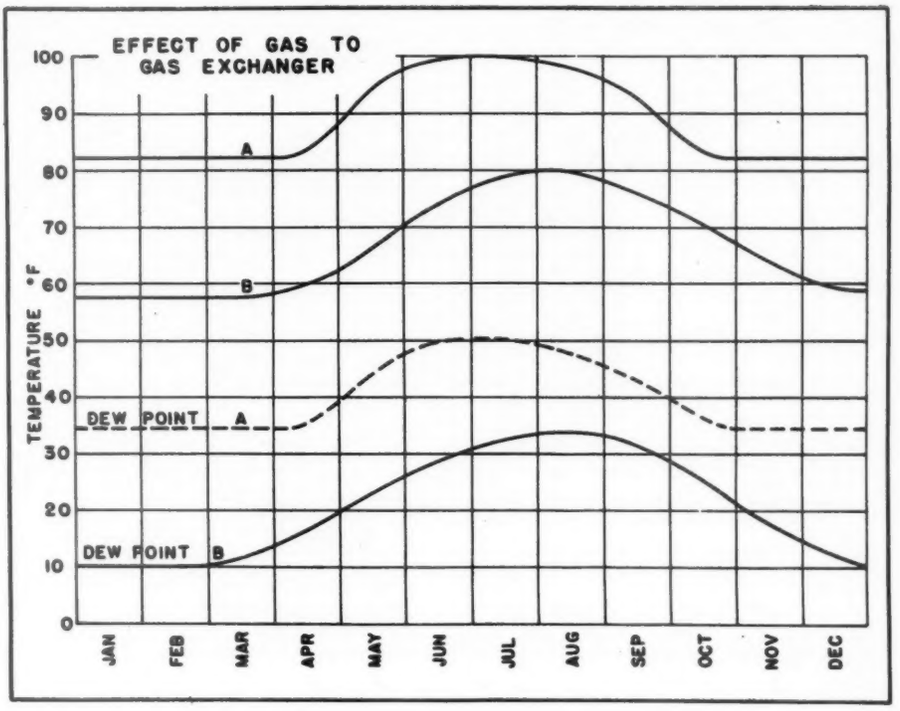
At Panhandle Eastern's compressor station near Liberal, Kansas, a bank of these gas-to-gas exchangers has been in operation for several years. Fig. 4 shows the year-round temperatures recorded at this setting.

The upper line is the temperature of the wet gas to the exchangers; the second line shows the temperature of this gas as it leaves the exchangers. Below these lines are two dew point curves, the lower being the actual dew point obtained and the upper a calculated curve of the dew point that would have been obtained without the gas exchangers. This lowering of the dew point required no change in the operation of the glycol plant proper. As gas-to-gas exchangers of this type need a minimum amount of attention, the increase in operation and maintenance charges occasioned by the addition of the exchanger bank was practically negligible.

A thorough, economic analysis of the desirability of adding gas exchangers to an existing installation can become a very complex proposition. Conditions at the particular plant and station under consideration have a great deal of bearing on the outcome of such a study. The general points to consider are:

1. The amount of cooling necessary to give the desired dew point.
2. The temperature level at which this cooling must take place. (This is important because it may eliminate some other means of cooling the gas.)
3. The effect of the exchangers on station horsepower and discharge gas cooling facilities—whether or not there is an excess of these facilities already installed.
4. The availability and cost of such other equipment as might reasonably be substituted for gas-to-gas exchangers.
5. Comparison of operating and maintenance costs of gas exchangers and any alternate proposals.
6. Dependability and uniformity of service.
7. Flexibility and simplicity of design.

FIG. 4



As for new plant installations where there are no existing facilities, a further point must be investigated, namely, the comparative advantages of a glycol plant with gas-to-gas exchangers and a solid type plant. Let us not digress too far, however, in the direction of general dehydration process designs. The important concept to retain is that the nature of glycol dehydration is such that a plant of this type may very possibly be modified so as to give better performance simply by incorporating a low temperature level heat exchange between the wet gas to the plant and a cooler suction gas stream.

Suction Gas Oil Cooler

Let us next consider the use of the suction gas as a coolant for the lube

FIG. 5

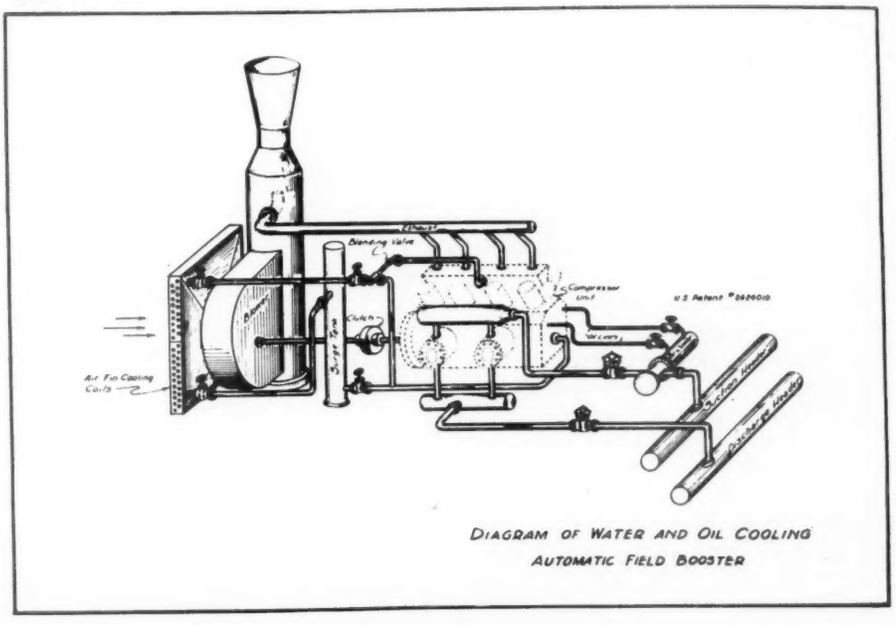


DIAGRAM OF WATER AND OIL COOLING AUTOMATIC FIELD BOOSTER

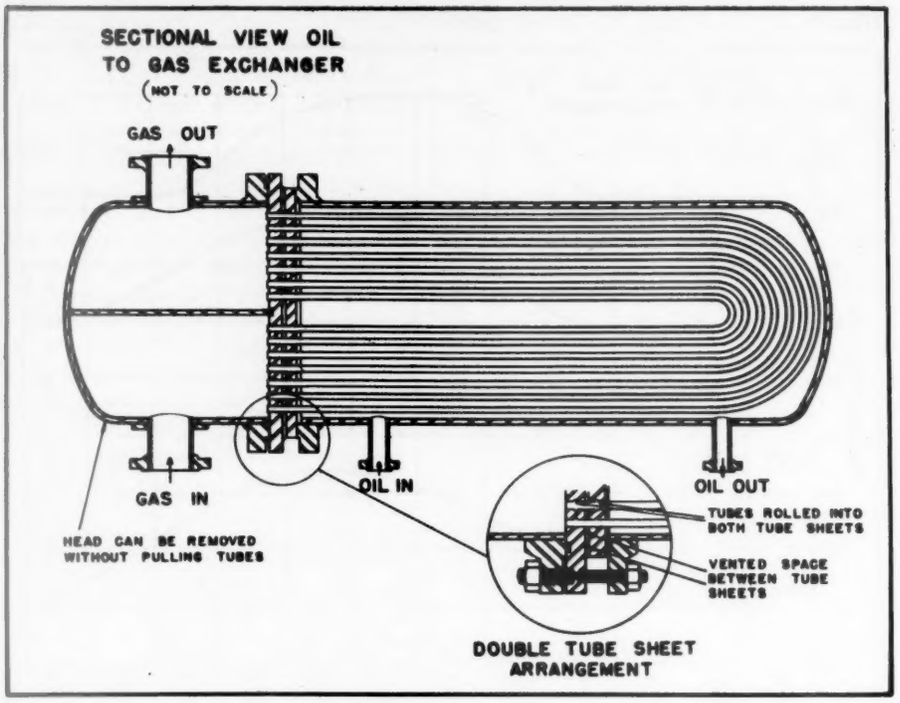


FIG. 6

oil of a compressor engine. This form of oil cooling was first used on the compressor engines of a small field booster that was intended for automatic operation. Due to the scarcity of water and the fact that the installation was to be unattended, the booster unit was designed to eliminate all water cooling tower services. The jacket water heat load, a quantity too large to dump into the gas stream, was dissipated by air coils, and the oil heat load, quite small in the case of the particular engines used, was picked up by the cold gas flowing to the engines. Fig. 5 shows the position of the cooler in the schematic layout.

Fig. 6 shows a sectional view of the oil cooler used. A double tube sheet arrangement was used as a safety precaution to obviate the possibility of gas leaking into the oil stream through the tube joints. A blow-out head and automatic shut-off controls protected the installation from damage in the event of a tube rupture. Provisions were made to trap and vent off any gas that might seep through pin-hole leaks into the oil, but this condition has never been encountered to date.

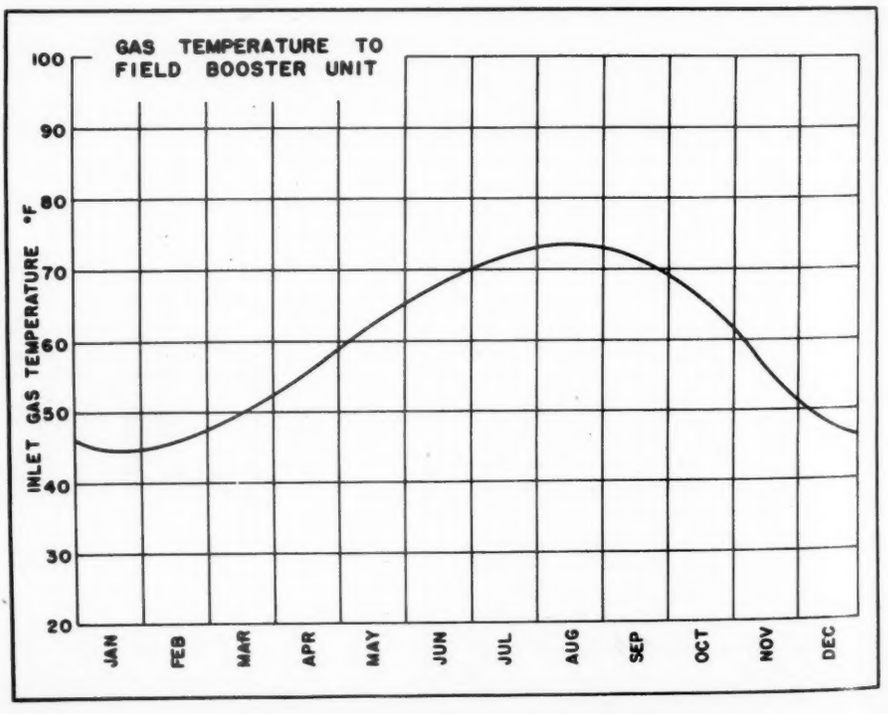
The question that arises, of course, is, "What about the effect on the horsepower requirements due to the higher suction temperature?" We know, from the basic theory of compression, that raising the temperature of a gas causes an increase in the horsepower required to pump a given quantity of the gas at a fixed compression ratio. The effect is undeniable, but the relative amplitude of the effect is the thing that is important. The amount by which the horsepower per million is increased is a deciding factor in determining the feasibility of such an installation. Referring to actual field data taken at the automatic station under discussion, a great deal of light can be thrown on this subject of temperature effect on horsepower.

The design basis for calculating the compressor horsepower assumed a 60 F suction temperature. The actual suction temperatures encountered at the station are shown in Fig. 7.

For six months of the year, the field gas reaches the station at temperatures below the 60 F design level; during this period, the true horsepower needed to handle the station's load is less than the design figure. Throughout the year, the station operates at a compression ratio that is essentially constant at 1.5, and, under such operation, the observed increase in gas temperature across the oil cooler is 2 F. Applying this temperature correction to the basic horsepower per million figure, the increase due to the presence of the suction gas oil cooler is 0.3 of 1 per cent. For an installed horsepower of 300, this amounts to 0.9 hp. Even with the additional consideration of the pressure drop through the exchanger, which, incidentally, is slightly less than 1 psi, the horsepower chargeable to the oil cooler is about 1 hp for a 300-hp unit. At $210 per horsepower and $1000 for the exchanger, this would amount to $1210. Not only would comparable cooling facilities of a different type have been more expensive to install, but they would have also involved greater operating and maintenance expenses. The gas oil cooler is ideally suited for automatic operation, whereas it is doubtful that a system using water or air as the cooling medium for the oil stream would lend itself to satisfactory unattended operation.

The same type of oil cooler has been applied to a main line station with comparable results. The cooler has 0.7 sq ft of surface per horsepower being

FIG. 7



The Vertical Aerotec Gas Scrubber sectioned to show Aerotec tubes, heart of this new scrubbing principle.

Proof

. . . that AEROTEC GAS SCRUBBERS *Really* clean gas

This pilot installation at Alice, Texas, used on very dry gas, was first installed on the discharge of a conventional type gas scrubber (position of first installation shown by arrows). In 18 hours of operation, this Aerotec unit collected 2 quarts of liquid, from gas that had passed through the conventional unit.

Installed at the inlet to the conventional gas scrubber, only one teacup of fluid was collected from the conventional type in 8 days, and this was probably condensation.

This is a typical example of field reports on the high efficiency of Aerotec gas scrubber units. Based on a modification of the principle of separation used in dust collection, Aerotec units have produced outstanding results, both at the well and on pipeline applications.

A catalog on operating and application data will be sent on request. Just write our Project Engineers, or the field office nearest you.

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GREENWICH, CONN.

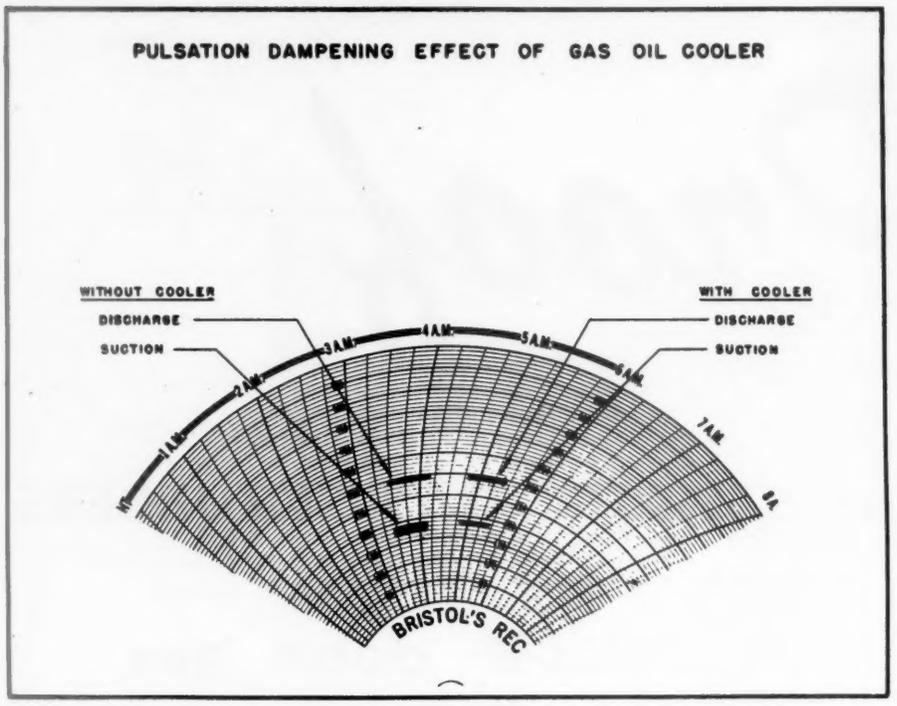


FIG. 8

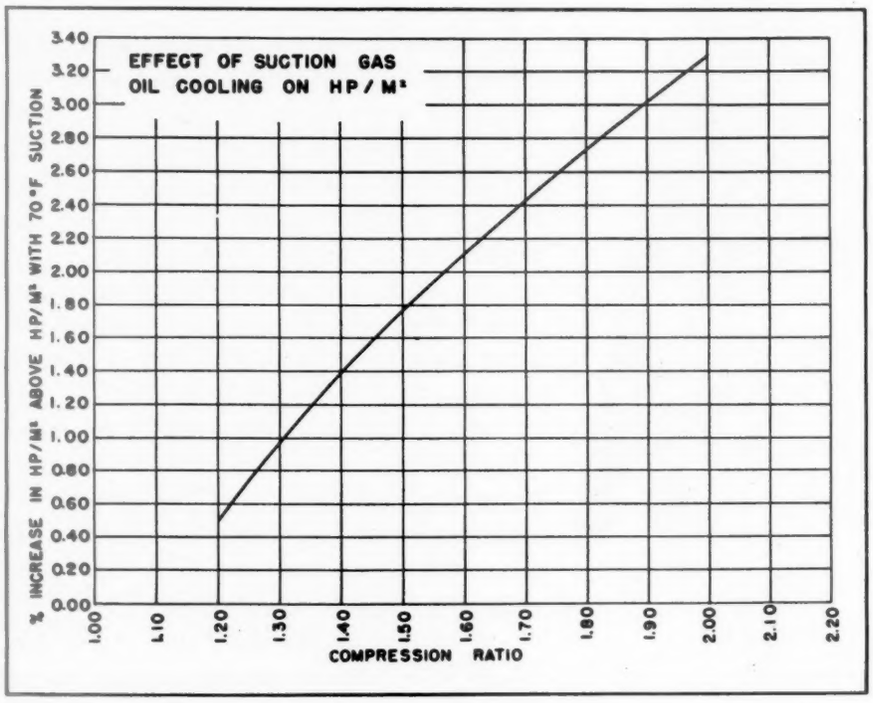


FIG. 9

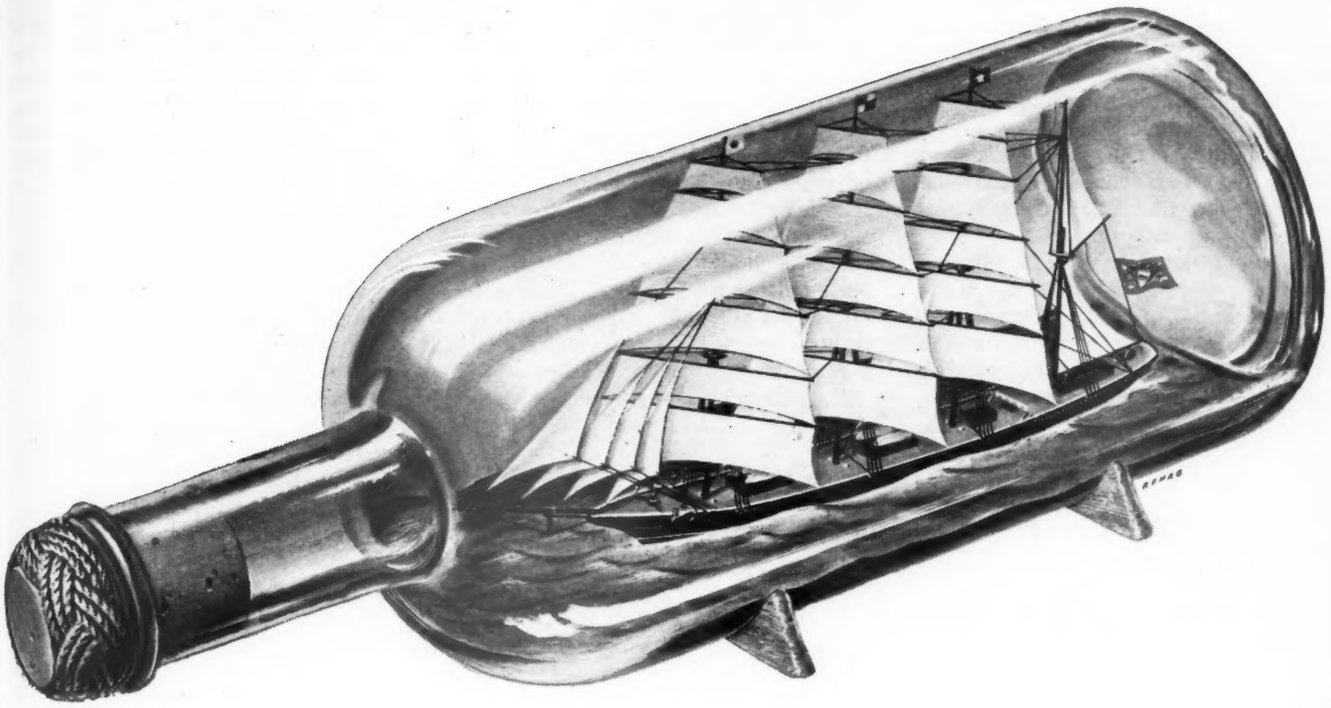
served, and the pressure drop on the gas side is 1.7 psi at full capacity. Another interesting feature of this cooler is the dampening effect it exhibits on pulsations that would ordinarily exist in the station suction header. Fig. 8 shows a portion of a pressure recorder chart. The recorded lines show the comparable amplitudes of pulsation obtained in the suction and discharge headers with and without a suction gas oil cooler. Notice the marked decrease in the degree of pulsation in the suction header when this cooler is used.

In the case of the main line station oil cooler, the temperature rise of the suction gas is greater than the two degrees mentioned in the previous example. This is due to two factors: First, the type of engine used at the main line station has a much higher heat load per horsepower; and, second, the compression ratio at the latter station is somewhat higher, so that less gas is pumped per horsepower. The loss entailed by the elevated suction temperature can be plotted as a function of the compression ratio for a particular type of engine. Fig. 9 shows such a plot; the ordinate of the chart is the percentage increase in the horsepower per million above the basic horsepower per million with a 70 F suction temperature. It should be kept in mind that the curve is not valid for all engines, but depends on the oil heat load of the type being discussed. This oil heat load may range from less than 100 to as high as 750 Btu per hp-hr in commercial types of compressor engines. The curve shown in the diagram is based on a figure of 625 Btu per hp-hr, which is a normal value for several common makes of engines.

Referring to the diagram, let us determine the effect of the gas oil cooler in a conventional design. On a main line station of a system with a station spacing within the range normally encountered on gas transmission lines, it is common practice to select horsepower on the basis of a 70 F suction temperature. This represents approximately the maximum condition encountered throughout the year. A normal compression ratio for the station may be taken as 1.4. From the curve, the increase in horsepower per million due to a gas oil cooler would be 1.38 per cent, but this loss would actually be realized from a design point of view only when the temperature of the gas from the cooler exceeded 70 F. In the case of a 1.4 ratio, this would correspond to a gas temperature of 60 F to the cooler. If a weighted average were to be taken considering that part of the year when the incoming gas was below 60 F, the overall loss would be about 0.6 to 0.7 of 1 per cent. Not only is this figure quite small, but it is within the degree of accuracy to which the engines can be indicated on load tests. Thus, the loss involved becomes a matter largely of academic interest insofar as it affects the necessary performance of the engine.

Summing up this application of gas cooling, it can be said that definite advantages can be obtained under the proper conditions by rejecting the oil heat load to the gas stream. This is particularly true when the problem of water scarcity is involved.

A third use of gas cooling was made by Panhandle Eastern in connection with the design of a small automatic field desulphurization plant to be installed on a well in the Texas Panhandle field. The plant was to operate totally without power requirements. The major problem of circulating the amine solution was solved through the



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Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 22" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	24" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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use of an alternately pressurized and vented dump tank, but the problem of interest to this discussion was the way in which the still overhead was to be cooled and condensed. Air cooling was considered as a possibility; natural convection and radiation to the atmosphere was one way of dissipating the heat. However, due to the wide seasonal variation in air temperature in that location, such a cooler would have to be designed for an extreme condition that might occur only for a short period of the year. When the air temperature dropped far below the maximum, sub-cooling and freezing difficulties could be expected, along with an unnecessary overload on the reboiler.

In contrast to the greatly varying air temperature, the temperature of the gas from the well was low and practically constant throughout the year. This design advantage suggested the use of gas cooling, a solution that offered the further advantage of a heat transfer rate corresponding to forced convection of the cooling medium. A small shell-and-tube exchanger was designed for the service and installed on top of the still. Several years of trouble-free operation have resulted; a side stream of sweet gas cools the still overhead and in turn rejects the heat to the ground through the pipe line.

The examples given here are only a few of the cases where the use of gas streams for cooling merit consideration. For instance, a possible application of this form of cooling has been suggested in conjunction with centrifugal compressor stations where a stream of seal oil must be cooled. Present trends in station and plant design make it necessary to re-evaluate the various solutions to the ordinary cooling problems. Progress is being made, both equipment-wise and cost-wise, toward the simplification of heat dissipation services. Naturally, there is no universally perfect answer to any general type of heat load rejection—each individual case involves its unique circumstances, which determine the most suitable and proper process for that particular job. Water availability, power and operation costs, and dependability of service are just a few of the factors to be analyzed. Each design must be approached with an open mind and an awareness of the many possible methods available to the engineer from which he can devise a satisfactory process to suit the need at hand. It has been the intent of this discussion to present the various aspects of one such method, and to clarify, inasmuch as a general treatment can, the considerations involved in the use of gas streams for cooling. * * *

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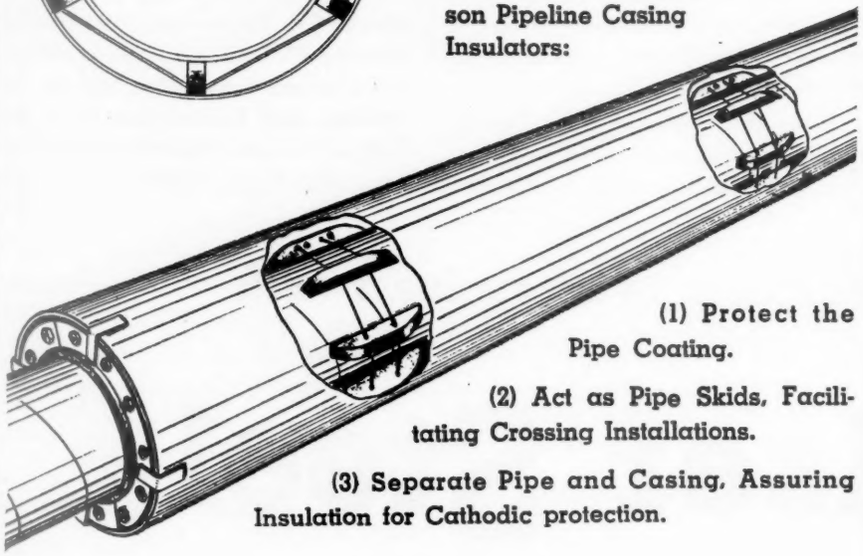
PIPE LINE CASING INSULATOR*

This improved Williamson Pipeline Casing Insulator approximately centers the line pipe in the casing. This removes support of pipe from "WmSEAL" Casing Bushings, and facilitates their installation. In addition, Williamson Pipeline Casing Insulators:



(1) Protect the Pipe Coating.

(2) Act as Pipe Skids, Facilitating Crossing Installations.

(3) Separate Pipe and Casing, Assuring Insulation for Cathodic protection.

FOR COMPLETE INFORMATION WRITE . . .

THE PIG WITH THE POKE CLEANS PIPE LINES

T. D. Williamson, Inc.
TULSA 9, OKLAHOMA

*Patent No. 2,097,398
Other Patents Pending

Piedmont's Motion For Reconsideration Denied

The Federal Power Commission has denied Piedmont Natural Gas Corporation's application for reconsideration and vacation or a rehearing of the FPC's March 30 orders that authorized Commonwealth Natural Gas Corporation to construct pipe line facilities to serve natural gas markets in Virginia and denied the portion of Piedmont's application proposing service in the Tidewater area of Virginia.

The March 30 orders, however, reopened the Piedmont proceeding insofar as it relates to that company's plans to supply natural gas to the Piedmont region of the Carolinas. Piedmont at that time was granted 60 days to amend its application to serve the Piedmont area and to produce further evidence if it so desires.

In denying this motion, the Commission found that no new facts have been presented or alleged and no new principles of law have been asserted under the various assignments of error by Piedmont in its application which were not fully considered by the FPC before it entered its March 30 errors and opinion in the proceedings.

P 615.331.

General view of operations at Harvey, Louisiana, plant. Pipe in foreground has already been coated and after overnight drying will be ready to lay.

Concrete-Coated Pipe Used For Swamps and Rivers

New method gives negative buoyancy, protects against corrosion, and permits use of thinner walled pipe.

DAVID J. KERR†

DOWN in the swamplands of southern Louisiana, where cypress trees and Spanish moss dominate the countryside, there is a new kind of pipe line operation being performed that eventually may change pipe laying methods in the marshy country, coastal areas, and across rivers.

In a region where pipelining is inherently difficult and frequent replacement necessary, a pipe coating process* recently developed by engineers of the H. C. Price Company, Bartlesville, Oklahoma, promises to cut costs and simplify construction problems.

This method calls for the application of a thick layer of concrete on the outside of oil and gas lines to give them a negative buoyancy and permanent protection against corrosion. Its salient feature is that thin-walled pipe can be used in locations normally requiring extremely heavy pipe.

The process was developed at the company's new Gulf Coast Somastic plant at Harvey, Louisiana, a few miles from downtown New Orleans. Opened last fall under the supervision of R. P. "Bob" White, the Harvey plant is presently turning out equal proportions of Somastic and Hevicote.

Any suggestion a year ago that concrete could be economically molded onto large-diameter gas or oil lines would have been ridiculed by most pipeliners. They could have offered a good argument that concrete would not adhere satisfactorily to steel pipe joints, and the thought of trying to handle cement-encased pipe in the field would have given nightmares to most contractors. Yet today there is adequate proof available that it is not only practicable but is the answer to many problems that have beset both

†H. C. Price Company.
*Patented under the name Hevicote.

EXCLUSIVE

Workmen wrap the Somastic-coated pipe with galvanized wire mesh to prepare it for Hevicoting.

The hopper car reaches the end of a run after having applied a fresh layer of concrete to another joint of pipe.

construction crews and pipe line system operators in swampy regions.

The initial demonstration of its usefulness was on the Mississippi River crossing of the Mid-Valley Pipeline Company. This crude oil pipe was laid last fall, with two 20-in. lines bearing both concrete and mastic. The ease with which the heavy concrete-covered pipe, made up in long sections for the crossing, could be handled, surprised veteran pipeliners. Its adaptability was shown more recently on the Transcontinental gas line to New York City. Fish Constructors, Inc., agents for Transco, requested a 7/8-in. application of concrete over enamel-coated pipe that was to be laid through delta country. More than 26,000 ft of 12¾-in. OD pipe were successfully coated.

A more extensive use has been by the United Gas Pipe Line Company on its Luling project in the marshy country west of New Orleans. This new line is a part of United's current extension of its gathering and distribution network through the South. A total of 25 miles of pipe for the Luling project received mastic coating, with more than 10 miles of this being given a concrete application.

Three Mile Shove

The United Gas line demonstrated that the concrete-coated pipe could be laid under the most difficult circumstances and with no more equipment or manpower for handling this overweight pipe than for regular lines. As evidence of this fact, at one location United construction crews were able to shove a 3-mile section of 16-in. OD pipe bearing both mastic and concrete covering across dense Louisiana swamplands with the use of only two tractors and a 15-man gang.

To appreciate the development of the process and the opportunities for its use it is necessary to have an understanding of the marshy terrain that subtends the Golden Crescent, the fabulous Gulf Coast border area. This delta country is unlike land anywhere else in the United States. It could be likened to a giant sponge — press down hard and water will come up. This region is interlaced with lakes, canals, and bayous that further complicate pipe line construction.

These conditions present tremendous problems to the pipe line operator. To lay a line in this land is to invite trouble in the form of large initial costs and a high corrosion rate that means frequent replacement.

Growing Need

Yet there is an ever-increasing need for new lines through this region due

to the rapid growth of the Gulf Coast as a producing area for both oil and gas. Even though the tidelands question remains unsettled, off-shore drilling is fast assuming an important position in the economics of the oil and gas industry. To move the crude products through the delta area by any other means than pipe lines is prohibitive, and yet those lines must not only resist corrosion but must withstand the destructive influences of barnacles and other marine growths.

The Harvey installation is a good example of both the problems that have to be met in this water-soaked land and the caliber of men that have set out to surmount them. The 12-acre Harvey plan was hacked out of a jungle-like swamp bordering the Intracoastal Canal three miles from its Mississippi River terminus. The land had to be filled in with logs and seashells to provide a dry spot for erecting the coating machinery. Huge piles were then driven into the soft ground to serve as a foundation for concrete platforms on which most of the equipment now stands.

Transportation Facilities

The location on the Canal gives the Gulf Coast plant a triple system of transportation, for the area is also served by highway and a line of the Texas and New Orleans Railroad. Water transportation being cheaper, most of the pipe from fabrication plants is brought in by barge and unloaded along the 1000-ft frontage facing the southern side of the canal. A giant crane aids in unloading and stockpiling the incoming pipe.

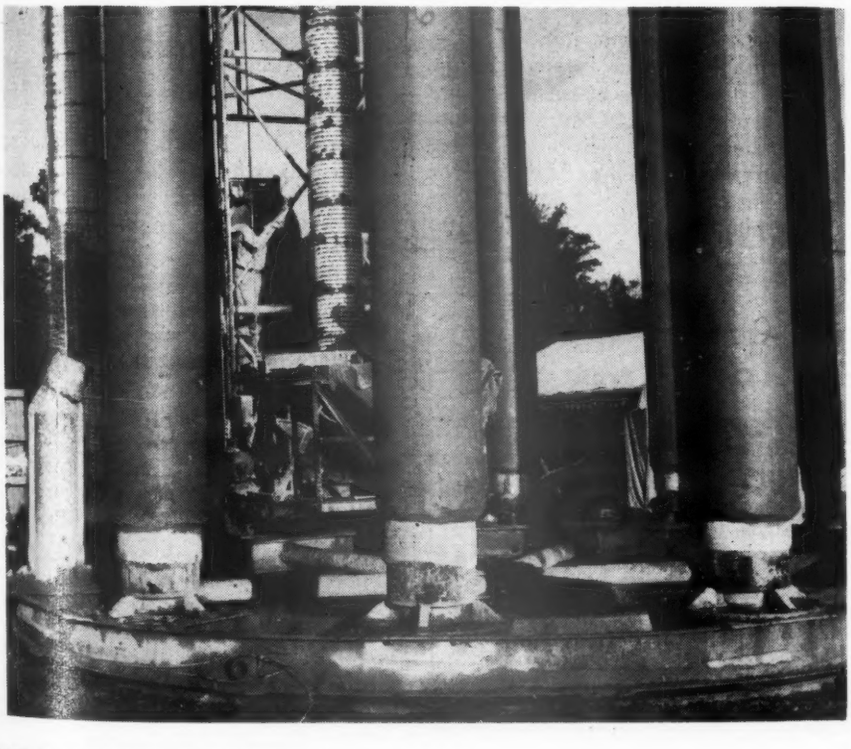
The supervisory personnel at Harvey include Bob White, Gulf division manager; Nelson VerSoy, plant superintendent; S. D. (Stubby) Pugh, Hevicote foreman; Vernon J. (Julius) Jones, Somastic foreman, and M. E. (Maury) Anderson, office manager.

Operations have been arranged at the installation so that the entire crew can shift between Somastic and Hevivote plants as the need arises. Inasmuch as every man is trained to handle a similar job on both plants, a changeover is comparatively easy.

The United Gas job, calling for a total coating of 171,000 ft of 16-in. OD pipe, gave the Harvey crew an opportunity to streamline its dual operations. On this project, both products were specified for a large proportion of the pipe (the Transco job and other tests have shown that Hevicote is equally satisfactory when applied to other types of coating than Somastic, or even to bare pipe).

Although specifications varied on wall thickness for the United pipe, both the mastic and concrete applications remained constant. The mastic coating ran 9/16-in. thick whereas the concrete was 1¼-in. thick.

Close-up of turntable adjoining coating tower at Harvey plant. End of joints are left uncoated to facilitate welding, then field molds are applied.



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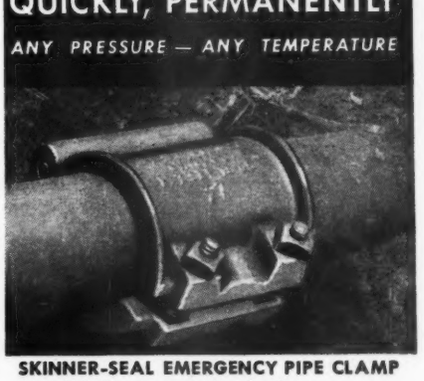
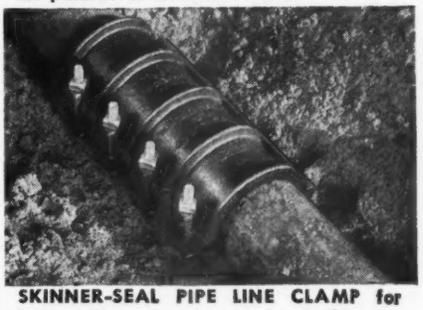


SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.



SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

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Coated with Somastic and Hevicote, this long section of pipe is being "shoved" across the Louisiana swamplands by a United Gas Pipe Line Company construction crew.

Negative Buoyancy

One of the important features of this double coating is that it gives the pipe a safe degree of negative buoyancy in an area where anchorage is a primary concern. The concrete application adds 72 lb per linear foot, while mastic adds 27.44 lb. The 16-in. pipe weight varies from 42.05 lb per foot on the ¼-in. to 82.77 lb per ft on the ½-in. With addition of nearly 100 lb of the two products, the total weight per foot ranges from 141.49 to 182.21 lb per linear ft. This means that the minimum negative buoyancy of the line is at least 10 lb per foot.

The Hevicote application begins after the pipe has been given whatever base coating the line operator has specified. It is then wrapped with a galvanized wire mesh that serves as a base for the concrete. The mesh used is 14-gage wire, with 2-in. square openings. A novel crimping machine speeds application of this wire mesh.

With the mesh in place, the pipe is moved by sidebooms to a platform a few feet from the plant. Here it is picked up by a 70-ft boom and swung into place on a huge turntable equipped with 12 spuds that hold the pipe in a vertical position during the coating process.

Adjoining the turntable is a 75-ft steel tower, equipped with a concrete hopper car that moves vertically up and down one side. As the turntable is rotated the pipe joints are brought into line with the hopper side of the tower.

The process starts with the hopper car at the top of the tower. The pipe joint fits through an aperture in the bottom of the funnel-shaped hopper car, which is lowered to the ground as the joint is held securely by an aligning spud at the top of the joint. The hopper is then filled with a sufficient amount of mix to coat the joint. As the car ascends, driven by a 10-hp motor, the weight of the concrete, plus the pumping action of the electric vibrators attached to the hopper, forces the mix out of the bottom of the hopper and onto the pipe.

Once the hopper car has traversed the length of the new joint of pipe, the turntable is again rotated and the process is repeated. The freshly coated joints remain on the turntable for approximately 30 min before their turn comes to be unloaded and laid out for overnight hardening.

The plant has averaged nearly 100 joints of pipe a day, which means that at least 4000 ft of pipe can be coated during an 8-hr shift. Once these joints have dried for 24 hr, they may be laid in tiers up to 4 joints deep.

Construction crews on the United Gas job discovered that the concrete-coated pipe could be handled with remarkable ease. As the pipe was brought to the field from the Harvey yard by barge or trucks, it was welded at a central kick-off point and "shoved" down the ditch. A short distance away, the freshly-welded joint received a field application of Somastic. As this field mold was unusually thick, no effort was made to add the concrete over the joints; however, a method has been developed whereby such field molds can be applied should they be needed.

One beneficial aspect of this swampy land is that mastic field molds can be readied in a hurry. The hot liquid coating, which is applied to the bare weld by use of a special steel mold, quickly cools under a dose of swamp water and the joint is ready to be shoved within 10 min.

The normal deflection of pipe coated with mastic and concrete was demonstrated at one location on the United line at Bayou Cygnet, west of New Orleans, where a crew "shoved" an 18,000-ft section of the heavy pipe around bends of 8 deg or better. To do this, two bare joints capped with a bull plug were placed at the front end of the section to act as a floating guide. In an uncanny manner, the long stretch of heavy pipe followed the ditch dredged among the jungle-like maze of trees and vines. * * *

Oil Lines Profit All

Scientific distribution methods developed by the oil industry mean lower operating costs to oil men and lower prices to consumers. For example, fourteen different oil products can be sent at one time through a single pipe line. The whole operation may be controlled from a dispatch board 600 miles away.

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HEAVY-DUTY Parsons 250 Trenchliner sets a fast pipeline pace . . . excavates 1½ to 3½ cu. yards per minute, depending on materials, depth and width requirements. 30 digging feeds, from 3.8 inches to 9 feet per minute, provide maximum digging efficiency in all materials short of solid rock. You get clean-bottom, smooth-wall trenches 16 to 42 inches wide . . . up to 12½ feet deep.

What's more, the 250 Trenchliner maintains steady, high-speed schedules and assures lowest operating costs because every assembly is extra-heavy duty . . . from its husky, fast-cleaning buckets, to the rigid arch-type frame that keeps digging boom precision-aligned. Safety overload clutch protects operating machinery from shock-loads. 3-point frame suspension maintains equal weight distribution on uneven ground, keeps twists and strains from main frame. All add up to trouble-free operation, more feet of pipeline trench per day, at lowest cost per foot, with Parsons heavy-duty 250 Trenchliner.

PARSONS COMPANY, Newton, Iowa

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P 615.635.4

Magnesiun Anodes and Common Sense

Intelligent Use of Magnesium as Source of Electrical Energy Can Lessen and Sometimes Eliminate Corrosion.

MARSHALL E. PARKER

IN USING any material for the purpose of protecting a valuable investment, is it not common sense to:

(1) Use the right amount of material?

(2) Distribute it in the right places?

(3) Install it in the correct manner? and

(4) Inspect the finished job to see if the desired results have been obtained?

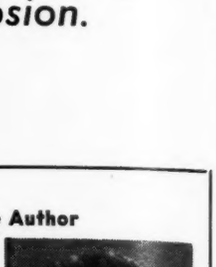
By the intelligent use of magnesium as a source of electrical energy for cathodic protection, the destructive action of corrosive soil and water on metallic structures can be greatly lessened, and in many cases entirely eliminated. In various forms, this energetic metal has been successfully applied to the protection of pipe lines, tank bottoms, drilling platforms standing in sea water, domestic hot water heaters, elevated water tanks, wells, condensers—to a wide variety of situations in which metal is exposed to soil or to water. As the protective action is electrolytic in nature, it is helpless against ordinary atmospheric corrosion—at least so far as present techniques are concerned.

It is known, however, that much magnesium has been installed, and feared that much more will be, that is not successfully doing the job for which it was intended, to the obvious disappointment of those who were expecting a solution to their problems. These failures have not been due so much to a failure to understand the basic principles involved as to a failure to see that the principles are applied in the field. In fact, almost all really disappointing occasions are directly traceable to failure to obtain information before, during, or after the installation.

How much magnesium is required? In many cases, this question must be asked several times before the project is completed, with answers of increasing accuracy being found as the work progresses; but some kind of estimate must be made before the job is undertaken at all. The current required to give a steel surface complete cathodic protection will vary between 1 and 10 ma per square foot, depending largely upon the electrolyte—the soil or water to which the metal is exposed. The real problem usually is the determination of the true area of metal in contact with the electrolyte, and hence exposed to corrosion and in need of cathodic protection. The total area is easy enough to determine, but when the structure has a protective coating, the equivalent in bare metal may vary from 1 per cent or less to more than 90 per cent. The corrosion engineer's approach to this problem may take one of two forms: With a sufficiently accurate description of the coating he may be able to estimate the requirements of the structure on the basis of past experience; otherwise, tests and measurements in the field will be required. Estimation by experience is the preferred method, provided the experience is adequate. It must be emphasized that either method will yield only a preliminary answer to the question; successive answers must be obtained while the work is in progress.

Probably the widest discrepancies between anticipated current requirements and actual current supplied by a successful cathodic protection system are to be found on cross-country pipe lines, particularly old coated lines. Great variations will be found in the electrical conductivity of the various soils traversed, and surprisingly large differences in the integrity of supposedly uniform coating are commonplace. Yet an experienced corrosion engineer can make a reasonably accurate estimate in many cases, and a reasonably accurate estimate is all that is required. If a test is necessary, it should be the simplest sort of a test; one that uses a temporary source of power, such as a welding machine, and actually puts a part of the line under protection. This avoids the complications involved in attempting to analyze mathematically the requirements of a line by combining the results of measurements to determine the soil resistivity, coating conductance, characteristic resistance, and other factors that determine the total current requirements. In addition to this obvious advantage, it is the only type of survey that can be conducted at a cost sufficiently low to justify it. Theoretically, it would be possible to conduct a survey on a pipe line in such detail as to make possible the complete office design of a magnesium anode cathodic protection system. It can be stated, however, that the cost of such a survey would exceed the total cost of a completely practical system, installed according to the following described preferred procedure.

The Author



Marshall E. Parker is a consulting corrosion engineer in Houston, Texas. His activities are confined largely to the field of cathodic protection, and include corrosion surveys, reports, and inspections. He was recently associated with Cathodic Protection Service, in which capacity he installed some 50,000 lb of magnesium anodes. Prior to that he was with Pan American Pipe Line Company, and has been a relay engineer, geodetic cartographer, and a teacher of mathematics, surveying and mapping, and aerial photogrammetry. He holds a BS from Sam Houston College, a BA from the Rice Institute, and is a registered professional engineer in Texas.

Preferred Procedure

First, the preliminary estimate of total current required is made, either through experience, or by means of a

EXCLUSIVE

current requirement test. Then approximately one-half or two-thirds of the amount estimated is installed and the results observed. From the response of the line to this partial installation, a very accurate estimate of the additional amount of magnesium required, and where it should be placed, is obtained. Thus all information that could possibly have been obtained by a very thorough and detailed survey is available by the time it is needed, and at far less cost. Actually, the adept and experienced engineer combines the two steps, feeling his way, observing the response of the line, and adjusting the density of application of magnesium as he progresses, so that he rarely has to double back and increase anode groups.

The same results may be obtained by one lacking in the judgment that comes only with long experience by a slight modification in the outlined procedure, involving only a small additional cost. The initial two-thirds is installed, precisely as described. The line is then permitted to polarize for a period of not less than two weeks, to permit stabilized values to be reached (values that the experienced engineer anticipates, although they are difficult to reduce to formula). Then an examination will disclose the deficiencies, and suitable additions can be made.

If the structure to be protected is more limited in extent and is exposed to a more uniform environment, the problem of estimation of current requirement is simpler. Such structures as water tank interiors, off-shore drilling platforms, water heaters and condensers fall into this category. The current required will vary from 3 to 10 ma per square foot in most cases. The higher currents will be required where there is rapid motion of the water, or elevated temperatures. Bare steel in sea water polarizes slowly, and may with difficulty be protected with 10 ma per square foot, unless resort is had to the (patented) process of laying down a calcareous coating by deposition of minerals from the sea water with an initial treatment of 50 to 100 ma per square foot for a period of one or two weeks. After this treatment, 3 ma will suffice to maintain protection indefinitely, minor breaks in the electrodeposited coating being self-healing by the temporary concentration of current at the exposed spots.

Steel surfaces exposed to fresh waters may be protected by a current density of 2 or 3 ma per square foot, if the water contains enough calcium and magnesium—about 40 parts per million minimum. A calcareous coating similar to that occurring in sea water is slowly built up by the protective current; the use of the high initial current density is rare in fresh waters. If, however, the calcium and magnesium content is very low, polarization is extremely slow, and no coating can be built up, the solution rate usually exceeding the rate of formation. Such water will require 5 ma per square foot or even more, particularly if there is much velocity of flow.

Structures that like pipe lines are exposed to soil attack, but unlike them are of limited extent, will usually be found to lie in fairly homogeneous soil. A tank bottom, for example, will rarely differ materially in its current requirements from one side to the other. Also, the fact that the structure is virtually an electrical point—that is, the structure resistance from point to point is quite low—makes it a reasonably simple problem to conduct a current requirement test whose result is an accurate picture of the total current required.

With all the above-mentioned structures, and with all the variations in methods of preliminary estimation of current requirement, the job is not complete until the question has been asked and a final answer received—has the amount of current supplied to the structure succeeded in protecting it? To omit this vital step is to value lightly all the work and expense that has gone before.

Distribution of Material

What is the proper distribution of the material? To this question there is assuredly no easy answer. Both mathematical analyses and field experience have shown that a given structure can be completely protected with a smaller total amount of current if this current is drained from a large number of well-distributed points than if all the protective current is drained from a single point. Both mathematical analyses and field experience agree, however, that this process of distribution need not be carried to extremes; a point is soon reached where further division of protective material into smaller and smaller units at closer and closer spacing increases costs faster than it saves material. The problem of distribution is to find the degree of dispersion that will present the most favorable overall picture.

This fact—the current economy of distributed drainage—is one of the basic economies of magnesium as a source of electrical energy for cathodic protection. By its very nature, it can readily be applied as many small units rather than a few large ones. Similarly, it is easy to vary the distribution, to concentrate the current where it is most needed, and spread it thin where the need is less. To fail to take full advantage of this characteristic is to fail to utilize material effectively.

On a bare pipe line, if full cathodic protection is sought, single anodes must be spaced at distances of a few hundred feet; the spacing will be determined by the current requirements of the line and the output per anode. At the other extreme, the total current requirements of a well-coated line may be supplied by grouping the required number of anodes in beds situated as far as 20 miles apart, without increasing the total current used by more than 5 per cent over the theoretical minimum with completely distributed drainage. Lines with coating of lesser quality will require closer spacing, and lines with generally good coating, but with sections of poor quality or damaged, will be protected most economically if anode stations are placed at these points of weakness. Rarely, however, is a coated line encountered that needs stations more closely spaced than half a mile.

Frequently, however, the spacing of anode groups is practically determined by another factor—the soil resistivities encountered. It is clearly more economical to install a given amount of magnesium in the form of a few large anodes than as a large number of small anodes; provided the current output per anode is great enough to make the larger sizes practicable. It is important, then, to seek out the sections of line lying in or very near to soils of low resistivity. If enough spots can be found with resistivity of 400 ohm-cm or lower, 50-lb anodes may be used with a useful life of ten years. The savings to be effected by the use of these large sizes will offset some slight increase in total current if the distances between such favorable locations is greater than the ideal minimum.

Another way in which soil resistivity affects the spacing of anode groups is by limiting the number of anodes that may be placed in a single group. Two anodes a few feet apart (ten, for example) will not put out twice the current of a single anode. Two factors are in operation here, one the crowding effect of the two anodes on each other, and the other the increased back potential of the pipe to which they are connected. Similarly, as more anodes are added at a single location, the increment of current per anode becomes less and less. Consequently, at each location there is a maximum number of anodes that may be used without the output per anode falling below the design value. A lit-

tle help may be had by increasing the spacing, but very little is gained by making it greater than 12 or 15 ft. When the limit has been reached for a given station, there is no point in moving only a short distance for the next group; rather should the distance moved be as great as possible, consistent with accessibility and proper soil conditions. As has been intimated, this factor determines the spacing of anode groups more often than any other consideration.

With structures other than pipe lines, the factors governing distribution are quite different. In freshwater tanks, for example, the proper anode size is determined by the water resistivity and the design life. With this determined, the remaining problem is to distribute the required number of anodes as uniformly about the surface to be protected as is practicable. A good rule of thumb is that no part of the surface should be more than twice as far from the nearest anode as the least distance between an anode and the surface. Any anode too close to the steel will tend to carry more than its share of the total current, with consequent shorter life, and the only dividend from this additional current will be over-protection of the adjacent surface. Again, two anodes placed too close together will tend to crowd each other, so that neither will put out the full amount of current desired. From this we deduce that anode spacings one from the other should be nearly uniform.

In sea water, the factors to watch most closely are the spacing of anodes from each other and their proximity to the structure. The crowding effect mentioned above will be present, as will the concentration of excessive current on parts of the structure too close to an anode. It is not necessary, however, to distribute the anodes uniformly about the entire structure, as the very high conductivity of sea water will facilitate the distribution of the current uniformly. This effect is still further heightened by the application of the pre-treatment with high current density described above; the calcareous coating forms first near the anodes, and, as the resistance rises due to its formation, more and more of the current is diverted to more distant surfaces, until finally a nearly uniform current density is reached throughout the structure.

Correct Installation

Correct installation involves more than correct distribution. On pipe lines, most effort is usually expended in locating sites at which anodes will deliver enough current. Inevitably a large number will deliver more than the desired amount, with resultant shortened life. This variation in anode life from station to station can be avoided by the insertion of adjustable resistors in the leads, so that all anodes can be adjusted for the same projected life. These resistors may take the form of short sections of Chromel wire, silver soldered into the circuit at the time of final adjustment. The measurement of current is facilitated by soldering in a shunt of 0.01 ohm value, which will permit the current to be measured with a potentiometer without opening the circuit.

In the interiors of tanks, it is usually possible to design a system sufficiently symmetrical to insure reasonably uniform projected life for all the anodes involved. In such cases, if the protection obtained is adequate, but not so great as to indicate current wastage by over-protection, and if the indicated life is satisfactory, there will be no need for resistors to limit the current output of the anodes. If the structure is found to be over-protected, a valuable extension of anode life can be had by limiting current output, without loss of protection.

Drilling platforms standing in sea water are usually irregular to the extent that the current output will be found to vary considerably with anodes in different positions. In order to obtain uniform life, current limiting resistors will then be required. It will also be found in nearly every case that the amount of current required to protect such structures diminishes with continued cathodic protection, so that successive replacements may be adjusted for longer life than the original installation. This procedure is simpler and more economical than that of redesigning the installation so as to obtain complete coverage with a smaller number of anodes.

A final necessary step in the successful use of magnesium for cathodic protection is making a survey of the protected structure to verify the actual establishment of protection. Various criteria for protection have been proposed, but the one most commonly used at present is the establishment of a structure-to-soil potential of at least 0.85 v negative, as referred to a copper/copper sulfate electrode. This measurement must be made with a potentiometer or a voltmeter with a very high internal resistance, in order to eliminate errors caused by the high circuit resistance. Vacuum tube voltmeters are in use for this purpose, and are highly satisfactory. An advantage of the potentiometer, however, is that the same instrument may be used to measure the current, by using the shunt mentioned above.

On a pipe line, potential readings should be taken at points midway between anode stations. If successive stations differ materially in size, a point nearer the smaller station should be checked, in order to be sure that there is no dip below 0.85 at the lowest point. On other structures, such as tank farms and complex networks of plant piping, a sufficient number of points should be checked to be sure that the least protected point is above the protected level; no hard and fast rule can be given, but any downward trends should be explored with additional readings.

Structures protected from water corrosion are frequently checked with a calomel electrode instead of using copper sulfate. The potential corresponding to protection with this electrode is 0.78 v instead of 0.85; otherwise there is no essential difference in its use.

Such surveys, including potential readings and anode currents, should be repeated from time to time, in order to discover any damage or any change in conditions that might affect either protective status or anode life. This will make possible the repair of damage or the revision of the system before damage to the structure is excessive, and will also facilitate the planning for anode replacement at the proper time. The omission of surveys leaves far too much to chance, and has been known to result in some major disappointments.

There are numerous additional refinements that may be employed in the use of magnesium for cathodic protection, refinements that may be amply justified in the name of research, or economically in the larger installations. Except in the very small project, where over-design and over-protection may be less expensive than engineering services, it is ordinary common sense to:

1. Use the right amount of magnesium; an amount that may be estimated with reasonable accuracy, but which in many cases must be tailored to fit in the field.

2. Distribute it properly; that is, to a degree that will insure full protection without too much over-protection, but not to a degree that increases installation costs to excess.

3. Install the magnesium correctly; with current output regulated for a known and uniform life, and with proper facilities for needed inspection and maintenance.

4. Inspect the finished job; verify the actual establishment of protective potentials, know the anticipated life of the anodes, and keep up with the status of the project by frequent instrumental surveys. * * *

5 Extra Value Features... *stop trouble before it starts*

1300-TPA-2091

E-M Heavy Duty 2 Pole Induction Motors, 800 hp. drive centrifugal pumps in a pipe line station at Drumright, Okla. Motors are started full voltage through E-M Hi-Fuse Controls.

Let's check the E-M features that stop trouble before it starts, guard against motor troubles and promote continuous operation . . . each a big step toward the elimination of shut-down.

I. **Fortifying the Coils against Moisture.** The completely wound stator is dipped in a flexible thermo-setting varnish . . . and then baked. Multiple coating and baking provide the type of protection operating conditions require.

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It will also give you some idea of why Electric Machinery of Minneapolis is known as "Specialists in Big Motor Engineering" and how this *high degree of industrial specialization* pays off for specifiers and users of E-M Big Motors, Generators and Controls.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

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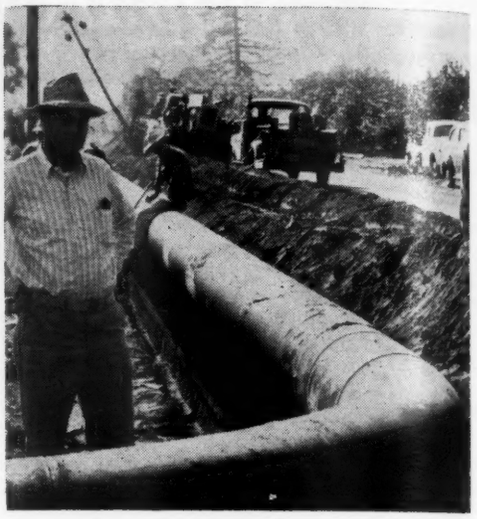
Specialists in

Big Motor Engineering

Two 45 deg bends formed by segments into line. L. E. Conway, project superintendent, Jack Cook, contractor's superintendent, and T. N. Banks, in charge of Project 1, are shown.

G. K. Shick, in charge of Project 2 of Goleta line, stands beside a 90 deg long-radius ell.



Long-Radius Ell Facilitates Pipe Cleaning

ARTHUR ROHMAN

PIPE line cleaning operations have been facilitated by the use and installation of a long-radius ell developed by engineers of the Southern Counties Gas Company of California, Los Angeles.

The new ell was used in the construction of the Southern Counties new 16-in. Moreno-San Diego line as well as on the two loops recently completed to boost the capacity of the more than 100.mile pipe line between the La Goleta underground storage field north of Santa Barbara and the Los Angeles metropolitan area. Completion of the Goleta looping projects enabled the Southern Counties and Southern California Gas Companies to deliver a record 1,056,000,000 cu ft of gas to the companies' customers.

The effectiveness of the sweeping turns in the pipe lines was tested by cleaning the lines before placing them in operation. This was done by blocking off 2 to 10-mile sections of the line, and using "pigs" or "go-devils". To obtain full effectiveness of the wire bristles on the go-devil, it was pushed through the line at pressures ranging from 2 to 5 psi. At these pressures the pig showed a tendency to slow up or become caught in the line, usually at the sharp right angle turns heretofore generally used in pipe line construction.

To free the pig under these conditions, it was necessary to boost the pressure, sometimes up to 10 psi. Although higher pressures behind the obstructed pig would ordinarily dislodge it, the line pack would carry it at high velocity for considerable distances down the line. Not only did this condition reduce the effectiveness of the cleaning operation, but also there was a chance that the fast-traveling pig would hit another right angle turn with considerable force, possibly damaging the line.

A constant check on the location of the pig in the line was maintained by placing a 500 milligram capsule of radium in a removable cap on the cleaning unit. This enabled a technician using a Geiger counter, to discover the pig in the event it should become lodged or obstructed. In the recently completed cleaning operations the pig was not obstructed in passing through the line.

EXCLUSIVE

The long-radius ell was conceived by Charles F. Briscoe, manager of engineering services for Southern Counties.

The radius of the new ell is computed at three times the diameter of the pipe line under construction. This radius, which is measured from the center of the pipe to an imaginary point from which the course of the ell could be extended into a complete circle, would, in the case of a 20-in. pipe line, total 60 in. The longest radius previously used was 1½ diam, or in the case of 20-in. pipe, 30 in. Thus, the sweeping turn of the pipe line permits the passage of the cleaning device at a relatively constant speed with little or no pressure variation.

Corten type steel was used in the fabrication of the new type ell, the greater physical strength of this steel making possible the use of thinner-walled pipe. The ell was manufactured by rolling sheet steel of absolutely uniform thickness into true-circle tubes that can be inserted in the line as specifications require. As a secondary advantage, the long-radius ell can be cut into segments of any length and welded into line at any point. * * *

GIANT "GARDEN" OF GAS

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Consolidated Safety Relief Valves are "standard throughout" the vast new storage tank installations of the Warren Petroleum Corporation at Maysville, Oklahoma. And for the best of reasons . . .

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The outside bevel seat and floating guide construction eliminate leakage under discharge piping stresses. Maximum tightness assured for all conditions of operation.

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Makers of 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.

Radiotelephone Aids Corrosion Surveys

At this very moment electrochemical corrosion is gnawing away at a wealth of underground metal structures because of the lack of adequate cathodic protection equipment and protective coatings. One of the most important fields where constant surveillance is required against the insatiable appetite of corrosion is the gas and oil pipe line industry.

Seeking more efficient test and maintenance methods, crews of the Standard Oil Company (Indiana), Products Pipe Line Department, who conduct cathodic protection surveys and installations over many miles of pipe line throughout remote areas, have equipped their "rolling laboratories" with two-way FM mobile radiotelephone units. By installing the 30-44-mc low frequency radio system,* the Standard Oil Company pipe line survey crews can cover larger areas in shorter time and have accurate minute-to minute reports of the test progress.

Operating over the products pipe lines of Standard Oil Company, which extend over six states of the middlewest, the corrosion survey crews at regular intervals take direct current and voltage measurements along the pipe line, which are evaluated to determine the condition of the pipe coating between any two points. Also, these measurements indicate whether or not adequate cathodic protection has been obtained.

Radio communication plays an important part during these tests as instantaneous reports can be exchanged between the two crews making the test. In practice it is performed in this manner:

The test is begun at point "A", which is any given spot on the line and at which point current drainage is applied to the line so that measurements may be taken. Now, two crews depart in opposite directions along the pipe line from "A" taking readings as they proceed toward end points "B" and "C", which may be anywhere from 2 to 20 miles from point "A". By continual radio transmission of results an immediate and complete log of test progress is possible.

During the recording of the measurements in the direction of points "B" and "C" it might be necessary to increase or decrease the current drainage until more favorable measurements are procured. By the interchange of potential readings via radio the increment can be quickly agreed upon.

Interior of "rolling laboratory" car used by crews of Standard of Indiana, in making cathodic protection surveys over pipe line throughout remote areas. Two-way FM radio plays an important part in the efficiency of these tests. Note installation of 30-44 mc mobile radio unit.

The efficiency of this immediate radio communication between the two survey trucks is further illustrated when compared with telephone land-line conversation as used in the past. Before the introduction of radio, cathodic protection measurements were relayed by telephone, if such communication was available. In the more remote areas where telephones were not near the section of pipe line being tested, time schedules were set up between crews. After the current was applied in the line, definite findings and data could not be correlated until the two crews were able to communicate with each other. Many times this necessitated repeat tests, losing time and adding costs to the surveys. Numerous other instances have arisen in corrosion surveys where mobile radios have proved invaluable. Among them are notification of equipment breakdown, emergency operations and arranging a rendezvous at locations where extra personnel are required.

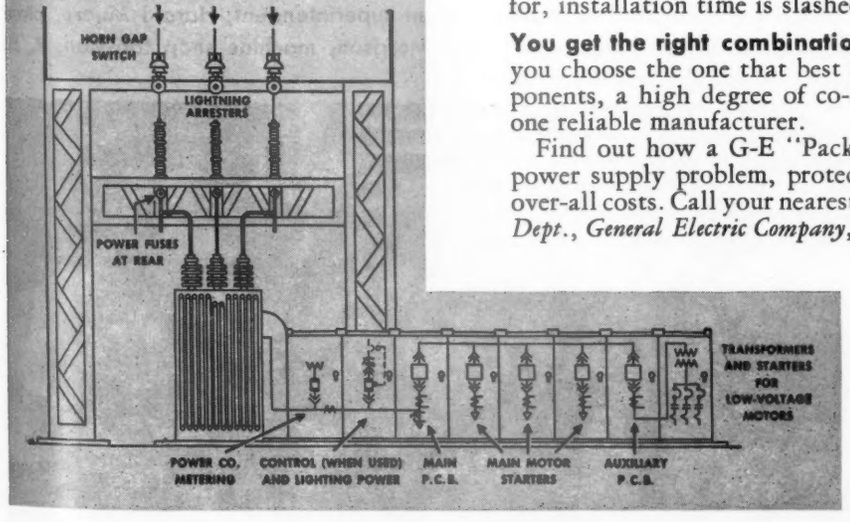
Now with two-way mobile radio, Standard Oil Company (Indiana) has added another application of radiotelephone to the pipe line industry, which is now being served with this type of communication in many other diversified activities. * * *

*Of Federal Telephone and Radio Corporation, Clifton, New Jersey.

Pipeline power distribution—
ALL YOU NEED IN ONE COST-SAVING PACKAGE!

Typical of the neat appearance and compact arrangement of G-E "Package" substations is this Texas pipeline-station installation. This one unit makes available 115-230-, 480-, and 2400-volt power covering all motor and lighting requirements.

What's in the "Package?" It comprises a complete outdoor steel switching structure—plus a master unit substation. The switching structure may include lightning arresters, disconnecting switches, buses and bus supports, potential transformers and current transformers, relaying and metering equipment, and outdoor oil circuit breakers (or fuses). The unit substation includes transformers and in the switchgear section, motor starters. Ratings are from 750 to 45,000 kva, at incoming voltages from 11 to 69 kv and outgoing voltages up to 13.8 kv.



This one cost-saver—a General Electric "Package" substation—combines *all* the electric equipment your pipeline station needs between incoming utility lines and all motor and lighting circuits. Ordered, designed, and built as a single unit, it comes complete, co-ordinated, ready-to-install.

You reduce system cost Because you don't have to order the components piecemeal, you save engineering cost, as well as time and trouble. And because the entire unit arrives in large, factory-built sections, installation expense is less.

You save time Less drafting and manufacturing time is needed because the over-all design is already largely complete, and the components are in stock or can be built repetitively. With no bottleneck parts to wait for, installation time is slashed.

You get the right combination From scores of standard combinations, you choose the one that best fits your needs. You get the finest of components, a high degree of co-ordination, and responsibility centered on one reliable manufacturer.

Find out how a G-E "Package" substation can solve your pipeline's power supply problem, protect your continuity of operations, help cut over-all costs. Call your nearest G-E office for more information. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Power supply for pipeline stations is one of many subjects vividly shown in "Lease on the Future," General Electric's "More Power to America" full-color and sound movie on oil field electrification. Ask your nearest G-E office to arrange a showing for you.

Everything you need to cut oil pipeline costs —electrically!

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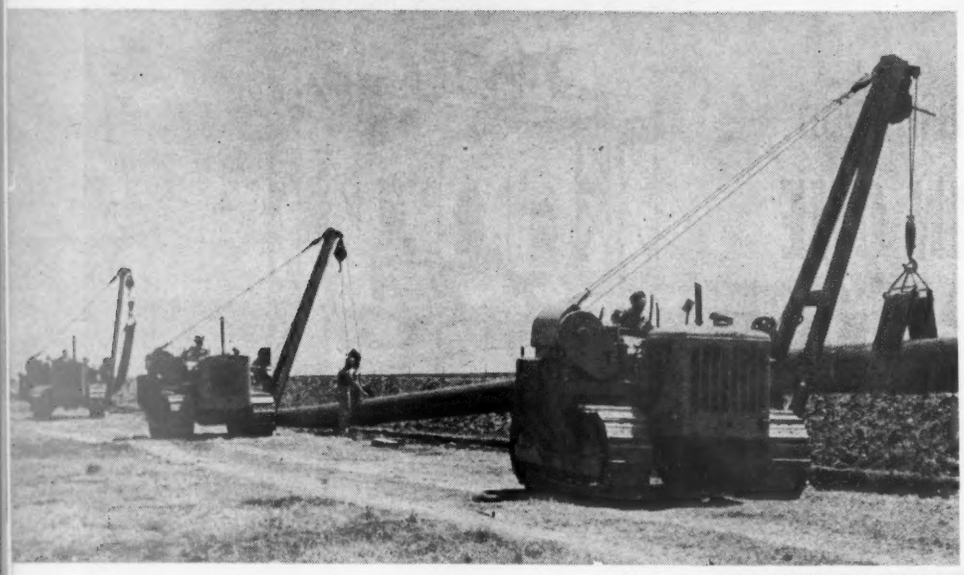
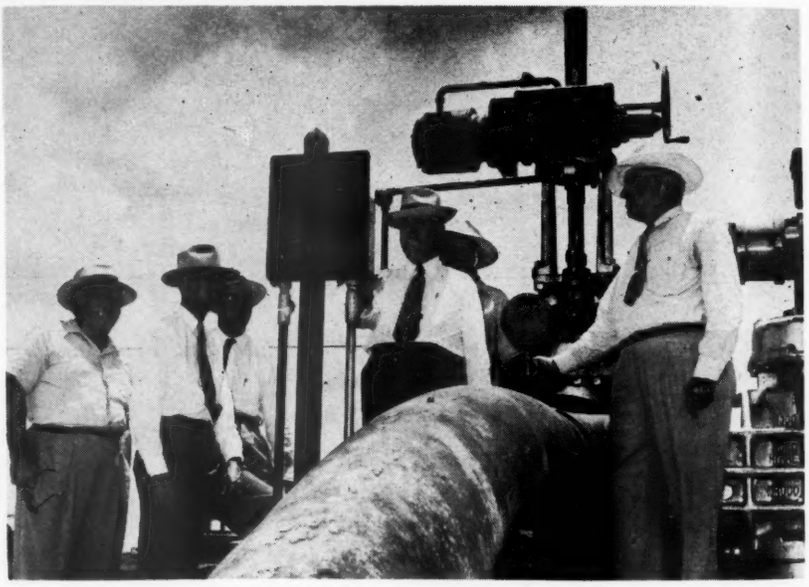
PICTORIAL



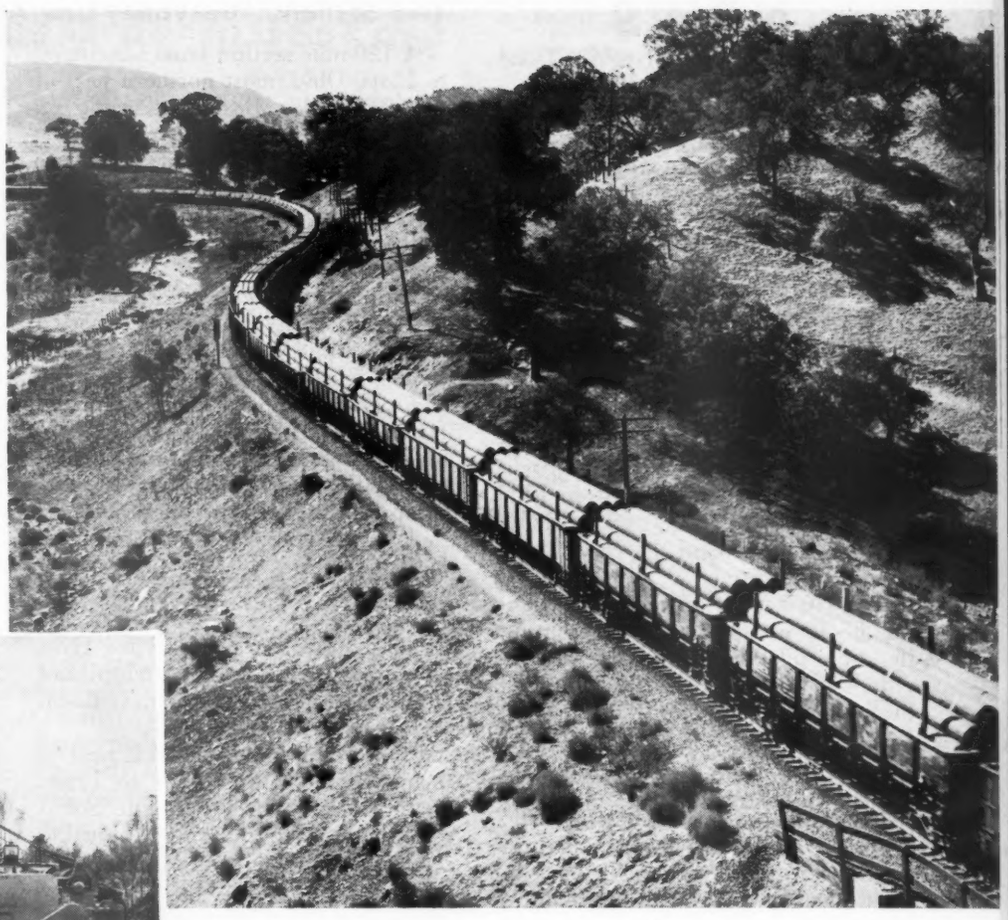
Lowering in 24-in. pipe on gas gathering system recently completed for Phillips Petroleum Company in Hansford County, Texas, by Vaughn and Taylor Construction Company, Inc.



The first oil through Humble Pipe Line Company's new West Texas-Gulf Coast line (see article in July issue) arrived at Satsuma June 13. Watching R. V. Hanrahan, president of Humble Pipe Line, pushing the button to allow the oil to flow to storage, are: H. C. Evans, Tomball district superintendent; W. S. Spangler, assistant superintendent southern division; O. Q. Lomax, vice president, Humble Pipe Line; Hanrahan; H. H. Hetzler, chief engineer Satsuma station, and A. E. Payne, superintendent of the southern division.

Operating crew at Hugoton station of Cities Service Gas Company. Front row: R. L. Ballard, dehydrator operator; Howard Parker, repairman; Theo. Fields, dehydrator operator; Elmer Ball, oiler; Eugene Carr, plant electrician; Gale Starns, repairman. Standing: Dave Lhuillier, construction engineer; Carol McCoy, assistant plant superintendent; Harold Moore, plant superintendent; C. W. Bowers, shift engineer; Jack Boyer, carpenter chief; Jack Morrison, machine shop foreman; R. H. Ballard, auxiliary engineer; Ed Kamma, repair foreman; Earnest Utt, oiler.

Trainload of steel line pipe produced on the West Coast by Kaiser Steel Corporation and Basalt Rock Company, bound for a pipe line project in Louisiana and Texas, of Texas Eastern Transmission Corporation. The 60-car train is shown winding through historic Tehachapi Pass in California over the Southern Pacific mainline.



Caterpillar diesel D8 tractor equipped with Trackson sideboom laying pipe near San Benito, Texas, on H. B. Zachry Company spread.

Four International TD-18 diesel crawler tractors with pipe booms carry a 240-ft river section of 26-in. pipe to water's edge as a TD-24 on opposite bank begins to take up on cable attached to end of pipe for haul into the river.

NEWS

Panhandle Eastern to Serve Indianapolis

The Federal Power Commission has ordered Panhandle Eastern Pipe Line Company, of Kansas City, Missouri, to connect its transmission facilities with those of the city of Indianapolis, Indiana, and to make available 10,000,000 cu ft of natural gas per day to the City's Citizen Gas and Coke Utility.

By its action, the commission concurred in the result of FPC Examiner Edward B. Marsh's initial decision, issued October 17, 1949, with certain modifications in the light of an FPC order of May 4, 1950, authorizing Panhandle to expand the capacity of its pipe line system.

The latest FPC order directs Panhandle to establish a connection in the Zionsville, Indiana, area, with facilities to be built by the city, and to deliver and sell up to 10,000,000 cu ft daily on a firm service basis. Deliveries are to begin by October 1, 1950, if the city has completed construction of its facilities by that date. The FPC said that the matter of providing additional volumes of gas to meet the growth in market requirements in Indianapolis can be considered in future proceedings.

The Commission found that no certificate is required under the Natural Gas Act by the city of Indianapolis for construction of the facilities to connect with Panhandle's system.

NACE Corrosion School Scheduled for Shreveport

Shreveport Section, National Association of Corrosion Engineers, has scheduled a 3-day corrosion school September 13-15 at the Caddo Hotel, Shreveport, it was announced by M. J. Olive. Pat Miller of Texas Eastern Transmission Company is chairman of the program committee. Aim of the school will be to familiarize field men with the nature of and means of controlling corrosion through discussions and demonstrations.

Phillips Case Hearing Postponed to September 11

The Federal Power Commission has postponed until September 11 the hearing previously scheduled to begin June 26 in Bartlesville, Oklahoma, in the proceeding involving the FPC's investigation of the natural gas operations of Phillips Petroleum Company. The Public Service Commission of Wisconsin and Phillips requested a 90-day postponement, and the commission's staff joined in the request.

Two Sections Mid-Valley Line Are in Operation

A 120-mile section from Cincinnati to Lima, Ohio, most northern part of the 1000-mile Mid-Valley crude oil pipe line, which will stretch from Longview, Texas, to Lima, Ohio, was in operation the first week in July, according to E. F. Morrill, vice president of Mid-Valley Pipeline Company.

The entire system, on which 1900 men are now laying pipe, is expected to be completed in October. It is owned jointly by Sun Oil Company and The Standard Oil Company (Ohio).

The 120-mile section from Haynesville, Louisiana, to Mayersville, Mississippi, has been in operation for some time, carrying crude oil from the producing fields to fill the eight new 81,000-bbl Mid-Valley tanks at Mayersville and to provide crude for loading on Sohio towboats for river transportation up the Mississippi and Ohio rivers to Mt. Vernon, Indiana, and Bromley, Kentucky.

From Mt. Vernon, the oil is pushed through Sohio pipe lines to Lima. From Bromley it goes to the Sohio refinery at nearby Latonia, Kentucky.

Eighty-nine per cent of the pipe for the 22-in. and 20-in. Mid-Valley line, one of the largest and longest interstate common carrier crude lines in the country, has already been delivered and the remaining pipe is being rolled for early delivery.

More than 2,000,000 bbl of oil will be required to fill the line, and an additional 1,000,000 bbl will be needed for minimum working stock in storage tanks, before through traffic in the big carrier can be started. Oil for this purpose is presently being accumulated and stored by Sun and Sohio.

Sixteen contractors are engaged in the work of completing the pipe line. There are eight major contractors on the pipe line itself, operating 12 "spreads" from construction points along the line.

Five contractors are building the seven major pump stations and two substations, together with the houses for personnel.

Another contractor worked on the major river crossings of the Mississippi and Red rivers and still another is erecting a micro-wave radio relay system, the most extensive in the world.

Contract for the micro-wave installation, more than 10 times longer than any now in service, has been awarded Motorola, Inc., of Chicago. Its cost alone will be approximately $750,000.

Using super-high frequency radio waves, similar to those in television, the system will provide private and instantaneous voice communication between Longview, Texas, and Lima, Ohio. The multi-channel radio relay will also enable pump station operators all along the 1000-mile system to talk to each other.

In addition, radio-telephone installations will be made in 30 mobile units. Similar to regular police broadcast systems, these will give personnel access to the micro-wave system while out in the field. A field superintendent, for example, cruising along a highway in the neighborhood of Longview, or any of the stations on the line, will be able to pick up the telephone set on his dashboard, and speak with any point he desires on the entire pipe line.

Tuscarora Reconstructing Line to Treble Capacity

Reconstruction of Tuscarora Oil Company, Ltd.'s 360-mile products pipe line system between Linden, New Jersey, and the Pittsburgh, Pennsylvania, area, has been announced by John de Groot, president. Tuscarora is an affiliate of Esso Standard Oil Company.

Originating at Esso's Bayway Refinery, the system serves the Pennsylvania area through five terminals near Reading, Altoona, Johnstown, Harrisburg, and Pittsburgh, and West Virginia at the western terminal with barge-loading facilities for service to cities along the Ohio River.

Already underway, the program includes the complete replacement of pipe of varying size with 10 and 12-in. diameter pipe and the installation of four large pumping stations to replace nine now in operation. Present capacity of 25,000 bbl a day of gasoline and distillate fuels will be raised to 45,000 bbl initially with a potential capacity of 80,000 bbl.

"Though reconditioned and modernized many times in its long history, this is the first complete replacement of the entire line," de Groot declared. "The new line will afford a greater and more efficient flow of products to meet the increased needs of consumers in the areas served by the system."

The first commercial common-carrier products pipe line, the system was established originally in 1908 for the transportation of crude oil. It was converted to a products line in 1930 but returned to crude service for military requirements during World War II.

The program is scheduled for completion in 1952.

FPC Rescinds Previous Order in Gas Case

The Federal Power Commission has rescinded its Order No. 139 issued August 7, 1947, which stated that the FPC would not assert jurisdiction over independent producers and gatherers of natural gas who might be subject to jurisdiction solely because of arm's-length sales of natural gas.

The commission pointed out that in the present Congress, a bill (H.R. 1758) designed to exempt producers and gatherers from the provisions of the Natural Gas Act was passed, but was vetoed by the President and did not become law.

The commission continued: "The President in his veto message returning H.R. 1758 to the House of Representatives, stated that he had no doubt the commission would operate reasonably and in the public interest in carrying out the present law. That is and will continue to be the policy of the commission.

"Accordingly, the following statement is issued in order that the public may be advised of the commission's policy in connection with the recission of Order No. 139.

"It is not the intention of the commission to inaugurate a general investigation respecting existing rates charged by producers and gatherers. Where, however, the sales of individual producers or gatherers have a material effect on interstate commerce and the rates therefor appear excessive, appropriate investigations will be undertaken. In this connection, the commission at present has under investigation the interstate wholesale rates of Phillips Petroleum Company, one of the largest producers of natural gas selling to interstate pipe lines.

"Upon conclusion of further studies of the operations of producers and gatherers and of the administration involved in their regulations, the commission plans to promulgate rules and regulations specifically applicable to them."

Commissioners Harrington Wimberly and Nelson Lee Smith filed a separate concurring statement, saying that "we concur in the action of the commission rescinding Order No. 139 only because that order does not accurately reflect the interpretation placed by the majority on the Natural Gas Act, and therefor the policy of the commission. Our views will be stated more fully in a concurring opinion to be filed."

Two Pumping Stations Are Back in Service

Increased production allowables for West Texas oil fields has resulted in Service Pipe Line Company pumping stations at El Reno, Oklahoma, and Childress, Texas, being placed back in service, J. R. Polston, general manager, has announced.

These stations had been on a standby basis since last September 1 when they were shut down because of reduction in transport requirements.

J. J. Peard, chief station engineer at El Reno, and A. M. Whitwell, chief station engineer at Childress, remained at the stations during the shutdown period.

With the stations going back into service, the following station engineers have been assigned from other locations in the company's pipe line system:

At El Reno: Harley W. Covington, from Kirby, Wyoming; Lee M. Harmon, from Elmont, Kansas; Joel B. Fields, from Maud, Oklahoma, and Clyde H. Ballard, from Cushing, Oklahoma.

At Childress: C. J. Driver and W. R. Eubanks, both of Fairbanks, Texas, and Sam Anthony and L. K. McClure, both from Bowie, Texas.

Relief station engineers were assigned at both stations. Austin J. Moss was named at El Reno, and D. S. Raney at Childress. Raney was formerly stationed at Ranger, Texas.

Both El Reno and Childress stations were built in 1946-47 during the company's postwar construction program and were operated from March 12, 1947, until they were shut down last September. They are main line stations on the company's Slaughter, Texas-Drumright, Oklahoma, 16-in. pipe line, through which is pumped crude oil from New Mexico and West Texas fields including production from Kent and Scurry counties.

Compressor Block Poured at Blythe

Pouring of the concrete block for installation of the tenth compressor unit at the Blythe compressor station of Southern California Gas Company has been completed, and the massive engine will be moved in soon reports C. F. Briscoe, manager of Engineering Services.

The new 1760 hp, 8 cylinder Clark compressor has been delivered to Blythe and is all ready to be moved in and set up on its foundations.

F. M. Banks New Head So. California Gas Company

Two officials of Southern California Gas Company resigned their positions in the company effective August 1 to retire under the company's uniform pension plan.

At a meeting of the board of directors in Los Angeles, the resignations of F. S. Wade as president, and of LeRoy M. Edwards as vice president and special counsel were presented. The latter also resigned as vice president and general counsel for Southern Counties Gas Company, and as vice president and general manager of Pacific Lighting Gas Supply Company, both affiliates of Southern California Gas Company.

The two men, however, continue as directors of the company, and Wade was elected chairman of the board of directors.

Edwards will engage in the private practice of law and at the same time he will be retained by both Southern California and Southern Counties Companies as special counsel.

While relinquishing entirely any active direction of the operations of the company, Wade, nevertheless, will maintain offices in the gas company building at 810 South Flower Street, Los Angeles, and will continue to be available to the company in an advisory capacity.

His place as president of the company was filled by the election of F. M. Banks, who becomes president and general manager. Banks was made vice president and general manager last August when Wade resigned from the general managership of the company.

Several official changes in the Pacific Lighting Gas Supply Company occurred as a result of the retirement of Edwards. At the regular monthly meeting of the board of directors, Robert A. Hornby was elected executive vice president; Marion L. Fort, former general superintendent, was elected vice president and general superintendent, and C. E. Pearman, former treasurer and comptroller, was elected vice president and treasurer of the company. Raymond W. Todd, chief engineer, was elected to the board of directors to fill the vacancy created by the retirement of LeRoy Edwards.

The board of directors of the company consists of Robert W. Miller, president; Robert A. Hornby, executive vice president; Marion L. Fort, vice president and general superintendent; C. E. Pearman, vice president and treasurer, and Raymond W. Todd, chief engineer.

Northern Natural to Erect Own Building

Northern Natural Gas Company has announced plans to construct a new main office building in Omaha, Nebraska. At present, the company rents floor space in the Aquila Court Building in Omaha.

The new home office will be near 24th and Dodge Street directly across from the renowned Joslyn Memorial, Omaha's art and cultural center. Completion is expected by 1951.

The expansion of the company's pipe line system since the end of the war has resulted in increasing the pipe line capacity from 242,000,000 to 600,000,000 cu ft and is expected to continue at the same rapid pace for several years. This has necessarily resulted in large increases in personnel, to the extent that the company has outgrown its present space and will require still further office space to meet the expected needs of the next few years.

To be six stories in height, the building will not be a showplace, but rather an extremely functional and practical office building.

The six-story building will be situated on land with frontage of 240 ft and 146 ft deep. Land has also been purchased for a company car garage with space for 40 cars. In addition, off-street outside parking on the grounds will accommodate about 75 more cars.

The new building will follow the latest trends in office buildings and will be similar in style to the United Nation's Secretariat Building in New York and the U. S. Steel-Mellen Office Building in Pittsburgh.

At present, Northern Natural employs 340 people in its home office.

The construction of the new building is part of Northern Mutual's 1950 expansion program, which will cost approximately $50,000,000. The company is raising its daily capacity from 470,000,000 to 600,000,000 cu ft.

Service Moves Kansas Headquarters to Wichita

Kansas division headquarters of the Service Pipe Line Company (formerly Stanolind Pipe Line Company) have been moved from Humboldt to Wichita, Kansas. The concern, which operates 1943 miles of oil pipe lines in Kansas, has 2400 sq ft of office space on the fifth floor of the KFH building. About 15 employees and their families will be transferred to the new location.

C. A. Childers, manager of the Kansas division, has brought six of his staff from Humboldt. The remainder will come, or already are on duty, from Stafford, Chanute, and Tulsa, company headquarters.

Childers said the move was made to place the headquarters in a more central location in the state. Much of the company's operations are in the western portion of Kansas.

The Kansas division is divided into three districts. Humboldt is the district headquarters for the "main line" of the system that enters Kansas in Chautauqua County and passes across the southeastern section of the state into Missouri in Miami County. The district has 136 miles of gathering lines and 131 employees.

There is another district headquarters at Stafford where 78 persons are employed. In this district the company operates 436 miles of gathering lines and 201 miles of trunk lines. The oil is pumped east through Eldorado to the main line at Humboldt.

The third district, with headquarters at Hays, employs 50 people. It has 288 miles of gathering lines and 179 miles of trunk lines. Oil gathered in Ellis, Rooks, Osborne, and Russell counties is pumped northeast to Washington, Kansas, and into the main Wyoming line. This pipe line, originating near the Montana line in Wyoming, moves over 50,000 bbl of oil a day southeast to the Gulf Coast-Chicago line at Freeman, Missouri.

Service Pipe Line Overhauls Tariff Rules

Service Pipe Line Company has announced a major overhaul of its tariff rules.

"The new rules clarify the old rules and in many instances effect changes which will afford added advantages and services to shippers using the company's common carrier facilities," J. L. Burke, company president, said.

Elimination of any minimum tender is the most important innovation in the tariff filed with the Interstate Commerce Commission and state commissions. The important departures from the company's old rules include:

1. A definition of the term "tender."
2. Provision for segregation of crudes of the same general characteristics into a number of common streams.
3. Reduction from 8 to 5 per cent in the amount deducted to cover losses in transit of natural gasoline and other natural gas liquids mixed with straight crude.

The new rules will be effective August 15, after being on public file with the commissions for 30 days, as required by law to allow any interested party an opportunity to protest.

"Another reason for this revision is to clarify and simplify our tariffs," Burke said. "Tariff simplification is a problem receiving attention of all types of carriers, not just pipe lines.

"The last general revision of our rules occurred in 1935. Since then, particularly since the late war, major revisions have been made in our facilities and operations. This modernization of our tariffs matches the modernization of our system."

Under the new rules any quantity of crude petroleum will be accepted from lease tanks or other facilities to which the carrier is connected, Burke explained. This provision replaces the former 10,000 bbl "minimum tender" rule. The only minimum quantity requirement now is that the carrier shall not be obligated to make a single delivery of less than 5000 bbl of a common stream oil. This is the smallest quantity it is normally practicable to deliver.

The new rules will apply not only to shipments moving via the lines of Service Pipe Line Company but also to those moving under joint tariffs over the lines of Service and other pipe line carriers connecting with Service, which have assented to the application of the new rules by filing notice of their concurrence in joint tariffs with the regulatory commissions. Rewording old rules has made them simpler and more definite.

NEWS

No Certificate Needed For Radio Installation

The Federal Power Commission has dismissed, for lack of jurisdiction, the application of Montana-Dakota Utilities Company, of Minneapolis, Minnesota, for authorization to install and operate radio facilities along the route of a natural gas pipe line now under construction in Montana and Wyoming.

The FPC said that the communication equipment falls within the scope of the installations described in Section 2.55 of the Commission's General Rules and Regulations and no certificate is required for its installation and operation.

Section 2.55 of the FPC's Rules and Regulations provides that the word "facilities," as used in Section 7(c) of the Natural Gas Act, shall be interpreted to exclude those installations that are merely auxiliary or appurtenant to an existing transmission pipe line system and which are installed only for the purpose of obtaining more efficient or more economical operation of authorized transmission facilities, it is pointed out.

Montana-Dakota is proposing to install 14 stations at various points along the route of the line and 12 mobile stations in cars and trucks.

Welding Publications Are Made Available

The Department of Welding Engineering of the Ohio State University announces that Engineering Experiment Station Circular 51 "Holdings in the A. F. Davis Welding Library" is off the press and is available on request.

This publication is made in answer to many requests to the university for information on published works in the welding field and those fields contributing to the science and art of welding. The list of titles is not meant to be a complete bibliography of the field but is published to assist corporations, individuals, and other libraries in using the Davis Library or in building their own collection.

The department also announces that the Engineering Experiment Station Bulletin 140 "Patent Classification in the A. F. Davis Welding Library" is off the press and available on request. This publication gives the outline of the patent classification index and explains in detail the operation and use of the system. The bulletin is designed to assist off campus users of the index.

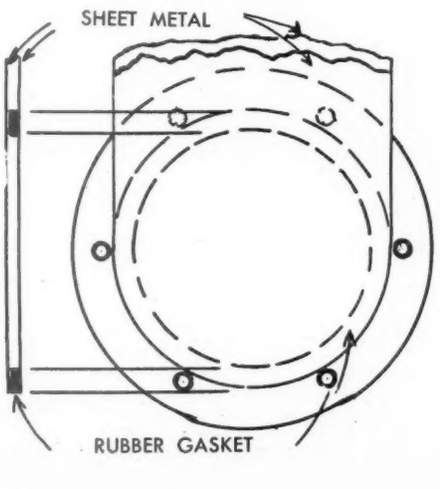
The Davis Library has maintained, for a number of years, a collection of patents relating to the welding industry and the patent classification system described in Bulletin 140 is an effort to make this collection of greater value to students and industry. The primary purpose of this project has been to provide, efficiently and on a wide scale, information on welding patents to industrial organizations and educational institutions. This classification aims to provide reference to fundamental patents on welding processes, materials, equipment, and patents.

Requests for Circular 51 or Bulletin 140 should be addressed to the Department of Welding Engineering, The Ohio State University, Columbus 10, Ohio. As long as the supply is adequate, single copies of the publications are free for general distribution; however, when the first printing is exhausted a charge of 50 cents per copy will be made for Circular 51 and 75 cents per copy for Bulletin 140.

Selection and Installation of Gaskets

In the selection of gaskets there are a number of things that must be considered. For instance, to what temperature will the gasket be subjected? Temperature has much to do with proper selection. Thus if the gasket will not be heated above 240 F it can be a non-metallic gasket. If it will be heated to a range between 240 and 800 F an asbestos or asbestos covered gasket may serve the purpose. If the temperature will run above 800 F a metal gasket usually gives the best service.

An important question is what kind of flange is used, as it is the flange that usually determines the type of gasket. Next comes the factor of pressure. Is it a liquid? Gas? Steam? Is it corrosive? Upon these things depend the kind of gasket material to use. You must not use rubber, for example, if the fluid is gasoline. You must not use copper if the gas is ammonia, etc.



What is the nature of the flange surface? It should be smooth, preferably, to facilitate perfect sealing. Perfect contact between the gasket and flange surfaces is essential to assure tightness and prevent leakage. Rough flange surfaces are a liability. The notion that roughness is necessary to prevent gasket slippage is fallacious.

How can I install a thin and flimsy gasket between flanges already in place in a pipe line? is a common question. The accompanying sketch shows how it has been successfully accomplished on large pipes with thin and flimsy rubber gaskets that were giving much trouble because of folding or buckling.

Let us say, for example, that you have a pipe joint that has been unbolted and the old gasket has been removed. The problem is to install a new gasket in place of the old one and be certain that it has not folded or buckled and that it is in its proper place. Do it in this way: Cut out two pieces of sheet metal as indicated in the sketch, one end being rounded to the exact curvature of the gasket. Place the gasket between the two pieces of sheet metal as shown in the sectional view, and then insert the assembly carefully between the flanges to the position shown in the sketch. Then carefully withdraw one of the pieces of sheet metal, and then the other, leaving the gasket behind in correct position for bolting.

Before inserting the gasket between the pieces of sheet metal make certain that no surface is "sticky" at any point so that the position of the gasket will not be disturbed when the pieces of sheet metal are withdrawn.

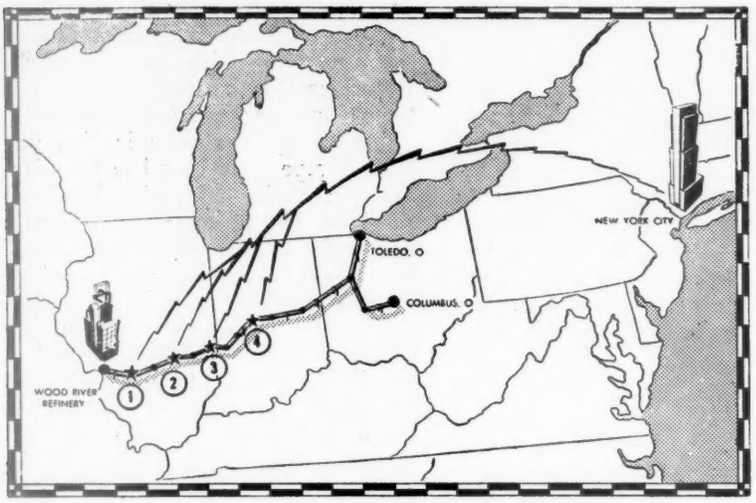
Special Tanker Division Of NFAS Is Created

Recognizing the importance of the tanker segment of the American Merchant Marine, and the specialized problems of this section of the industry, the National Federation of American Shipping has created a special tanker division to follow conditions and problems in this field and to give technical aid and assistance to the Federation and its tanker owners in all matters relating to the building and operation of tankships at the industry level.

The new division will be headed by Joseph S. Oppe, a man of wide experience in the operation of tankers.

Oppe resigned from the Economic Cooperation Administration where he was in charge of the tanker division under Colonel Arthur G. Syran, chief of transportation. Previously Oppe has been assistant director of tankers for the War Shipping Administration and before that in responsible positions with private tanker owners.

Four new completely remote-controlled pipe line pumping stations in the Midwest were put into operation by the spin of a dial from the RCA Building in New York City. The line carries petroleum products from the Shell Oil Company's Wood River, Illinois, refinery to industrial centers farther east at Toledo and Columbus, Ohio. From a dispatcher's office in New York City the new stations at New Douglas, Illinois (1) Effingham, Illinois (2) Dennison, Illinois (3) and North Salem, Indiana (4), are operated by long distance wire.



A 17-ft control board in Shell's New York office traces the progress of every gallon of oil product in the 450-mile pipe line in the Midwest. Shell dispatchers set markers and adjust the charts to show exactly where each product is, 24 hours a day.

"Push-Button" Pipe Line Stations

A new type of pipe line pumping station in which pumps may be started and stopped, valves opened and shut, and reports made automatically on operating conditions, all at the will of a man 850 miles away, was put into operation July 17 by Shell Oil Company.

At 2 p.m., D. B. Hodges, Shell's vice president in charge of transportation and supplies, dialed code numbers on a telephone dial attached to a teletype machine on the thirty-fifth floor of the R.C.A. Building, New York. Seconds later, pumps were in operation at four new stations in New Douglas, Effingham, and Dennison, Illinois, and North Salem, Indiana.

These new pumping stations, together with several others of an earlier type of construction, are situated along a products pipe line extending from the company's refinery at Wood River, Illinois, near St. Louis, eastward to Lima and Columbus, Ohio. Unlike a crude oil pipe line that handles only a single liquid, this line is equipped to carry to market up to 22 different finished petroleum products, pumped through the line one after the other.

Movement of products through these new stations is directed from a point hundreds of miles away. Electrically-controlled pumps start and stop upon receipt of signals transmitted via teletype, and electrically-motivated valves are made to open and shut in the same way. The most uncanny feature of the new system, however, is a set of meters that report to New York via teletype the suction and discharge pressures and electrical load of each station any time the teletype dial on the New York end asks for this information.

The new stations are not wholly without the human touch, however. One man is assigned to each station to perform routine upkeep and maintenance, and to operate by hand any of the controls, if necessary. A siren is provided to summon the attendant in the event of such a necessity, and like everything else at the station, it is set in motion by a man at a teletype machine in New York City.

The reason for central control of a products pipe line is the great variety of products that it handles. One after the other, gasoline, naphtha, kerosine, fuel oil, and other bulk products are pumped through the line. At convenient intervals, a portion of the products is taken off and put in tanks for distribution to local customers. Without scheduling of these take-offs from a central point, the operation of a products pipe line would be a hopeless muddle. At Shell's main office in New York, this work is handled by a central dispatching office connected by teletype to each station on this and two other lines that the company operates in other parts of the country.

The mechanism of the new automatic station was made possible by the cooperation of three other companies. General Electric provided the switch gear, controls, and accessory equipment; American Telephone and Telegraph Company, the teletype relay equipment. The Bailey Instrument Company developed the "telemeters," which make possible the automatic reporting of pressures and electrical loads.

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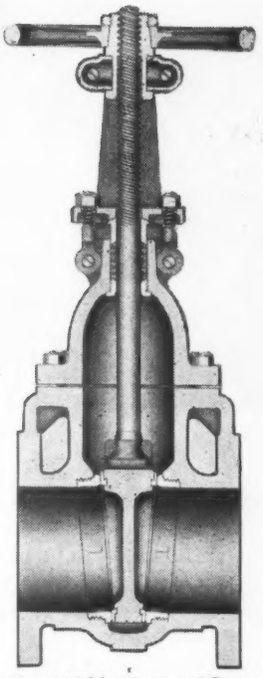

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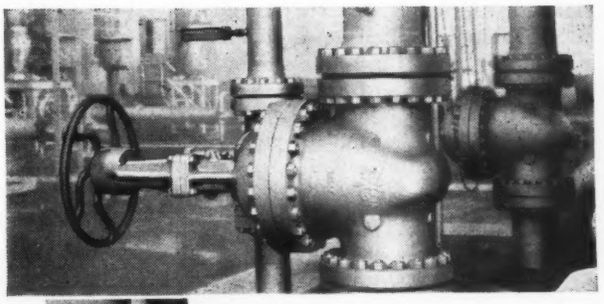
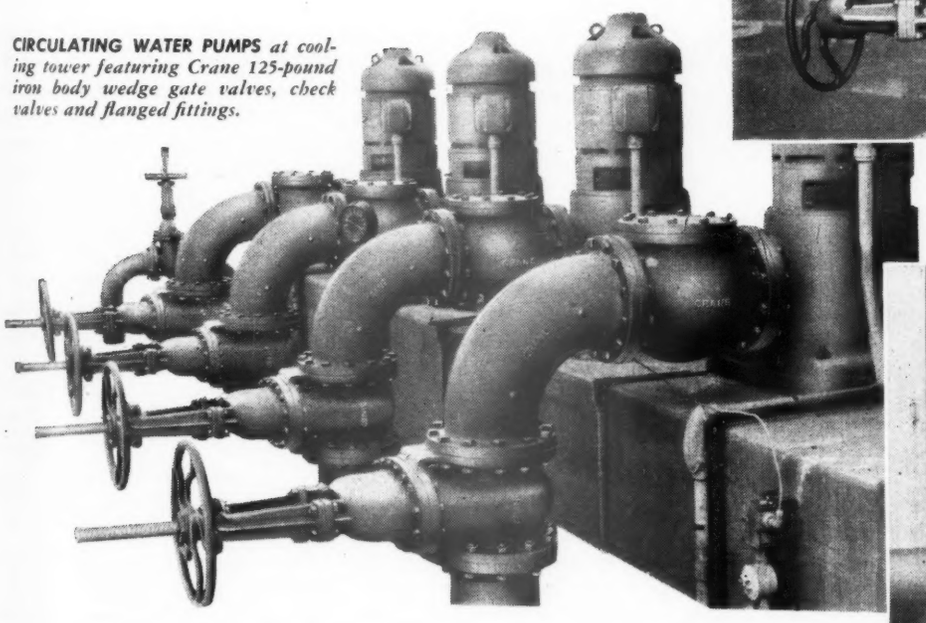
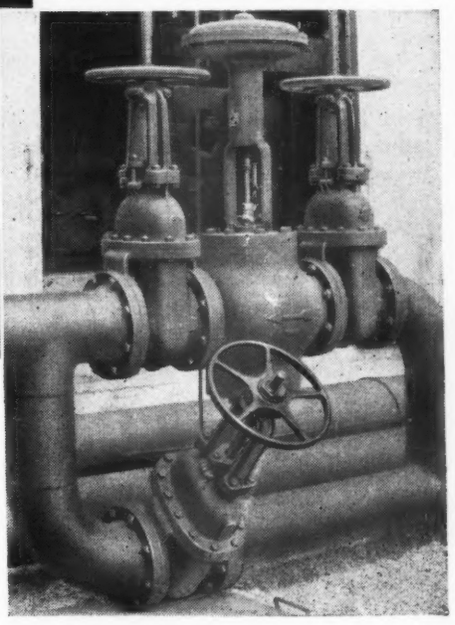


CIRCULATING WATER PUMPS *at cooling tower featuring Crane 125-pound iron body wedge gate valves, check valves and flanged fittings.*



CRUDE OIL FIELD LINES *showing regulator with Crane iron body wedge gate valves in fabricated by-pass arrangement.*



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- PIPELINE PERSONALS -

W. F. Davis

One of the most important temporary assignments with Lakehead Pipe Line Company to be filled by an Interstate Oil Pipe Line Company employee is the loan of W. F. Davis, assistant to the northern division general superintendent, for a 12-month period during which he will be assistant manager of the new pipe line firm.

Davis was granted leave of absence from Interstate for this period, and reported in at Lakehead headquarters in Superior, Wisconsin, on May 29. Lakehead is the American partner of Interprovincial Pipe Line Company in developing the 1150-mile pipe line outlet for Canadian oil from Edmonton, Alberta, Canada, to the Great Lakes terminal at Superior, Wisconsin.

In May, 1942, Davis joined Interstate's predecessor, Oklahoma Pipe Line Company, as district engineer at St. Elmo, and the following September moved to the engineering department in Tulsa. During 1944 he was on special assignment in Mississippi, when Oklahoma acquired the Pickens field gathering system, and later in the year was on a similar assignment in Montana.

Davis was named superintendent of the Illinois district in August, 1944, and remained in that position until assuming his present post as assistant to the general superintendent of the northern division on June 1, 1948.

John J. Heusner, assistant foreman at Meade, Kansas, for Panhandle Eastern Pipe Line Company, has been transferred to the same job at Stinnett, Texas.

Warren L. Ambrose, personnel assistant in the employee relations department of Interstate Oil Pipe Line Company, Tulsa, Oklahoma, resigned to accept a position in the crude oil purchasing department of Cities Service Oil Company in Fort Worth, Texas.

C. L. Pilkington, timekeeper at Ottawa, Kansas, for Cities Service Gas Company, resigned to accept a position as district foreman with the Michigan-Wisconsin Pipe Line Company. His new address is Meade, Kansas. **Robert R. McDaniel** has been transferred from Blackwell to Ottawa as timekeeper. **V. E. Smith,** industrial enginer, has joined Cities Service and has been assigned temporarily to the meter shop at Wichita. **C. G. Tuttle** also has joined the company and has been assigned to the meter shop for the time being.

J. E. Norris, who has served as maintenance man and in the compressor station department in the Shreveport, Houston, and Dallas districts, and the Shreveport general office of United Gas Pipe Line Company since his employment August 5, 1947, has been promoted to meter inspector helper in the Dallas district.

N. W. Freeman, assistant to the president of Tennessee Gas Transmission Company, Houston, Texas; **R. L. McVey,** controller; **Harold Burrow,** manager of the gas supply department, and **Louis Sonnen,** manager of the purchasing department, have been elected vice presidents of the company by the board of directors. The announcement was made by **Gardiner Symonds,** president.

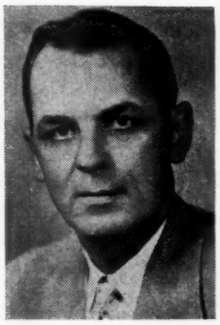
All are veteran executives with the company. Freeman, Burrow, and Sonnen joined the company during its formative stages in 1943, McVey in 1945. All have played a major role in building the company to its present position as one of the nation's major interstate natural gas transmission companies.

"The election to vice presidency of these four men by the board was partly in recognition of their past accomplishments with the company and partly in view of the expanded duties that have been placed upon them," Symonds commented.

Freeman first joined the company as manager of the personnel department and became assistant to the president in 1947. McVey came with the company as assistant to vice president and became controller in 1947. Burrow was first purchasing agent, then director of purchasing and in early 1949 was made manager of the gas supply department. Sonnen also began with the purchasing department and was made head of the purchasing department in early 1949.

H. A. DeVilbiss, electrical maintenance supervisor for Shell Pipe Line Corporation, has been transferred from Cushing, Oklahoma, to Kilgore, Texas. Other personnel changes include: **L. L. Ermis,** senior clerk, personnel, to area training representative, Colorado City, Texas; **J. P. Gunn,** district gauger, Cushing to Elk City, Oklahoma; **W. Hale, Jr.,** field gauger to district gauger, Denver City, and **H. W. Smith,** electrical maintenance supervisor, Kilgore, to area electrical engineer, Houston, Texas.

Jess Krueger, cathodic protection supervisor for Northern Natural Gas Company, has been moved from Beatrice to the Omaha, Nebraska, main office.



Ross V. Osterhout

Ted I. Reese

Ross V. Osterhout and **Ted I. Reese,** special representatives of Caterpillar Tractor Company, have been named to assist in the introduction of the company's new portable pumping unit to the pipe line industry, according to a recent announcement by **C. E. Jones,** manager, Caterpillar sales development division.

Osterhout, son of a drilling contractor, has been with the oil producing industry for many years. Prior to joining the engine sales division of Caterpillar Tractor Company in 1943, he was associated with National Supply Company, Continental Supply Company, Sinclair Oil Company, and the I.T.I Oil Company.

Reese started with Caterpillar Tractor Company's service department in 1942. Shortly thereafter, he joined the U. S. Army Corps of Engineers where he helped maintain heavy equipment during the war years. He returned to Caterpillar in 1947 as a member of the service claims department for the eastern sales division and remained in that capacity until his recent transfer to the sales development division of Caterpillar's sales department.

▸ **W. L. Kygar,** Ponca City, Oklahoma, has been elected president of Continental Pipe Line Company, which has approximately 2000 miles of pipe lines and gathering systems in Oklahoma, Texas, Louisiana, New Mexico, Kansas, Indiana, Wyoming, and Montana. The announcement was made by **President L. F. McCollum** of Continental Oil Company. He assumed his new duties August 1 and is making his headquarters in Ponca City.

G. W. Evans

W. L. Kygar

It was announced simultaneously that **George W. Evans,** Houston, manager of Continental Oil Company's transportation and purchasing departments, has been elected chairman of the board of the pipe line company.

A. C. Wilkinson, Ponca City, will continue as vice president and manager of Continental Pipe Line Company, it was said.

Kygar, who has been associated with Continental Oil Company for more than 25 years, was formerly assistant manager of the company's motor transportation division, but spent many years in pipe line and production operations. He is the son of Dan Kygar, veteran pipe line official who was formerly associated with the old Marland Pipe Line Company and the Kay County Gas Company.

Born in Ponca City, Kygar attended school here and was graduated from the University of Oklahoma. He joined Continental Oil Company in October, 1926, as an accountant and after numerous promotions in pipe line and production operations he was named assistant manager of the motor transportation department in 1948.

▸ **James S. Moulton,** vice president and executive engineer, Pacific Gas and Electric Company, San Francisco, has been named chairman of the American Gas Association Distinguished Service Award Committee, it was announced by **Hugh H. Cuthrell,** president, AGA, and vice president, The Brooklyn Union Gas Company. Other members of the committee are: R. **L. Fletcher,** president, Providence Gas Company, Providence, Rhode Island; **S. B. Irelan,** president, Cities Service Gas Company, Oklahoma City, Oklahoma; **Kurwin R. Boyes,** secretary, AGA, secretary of the committee.

This award, consisting of a substantial sum of money and a certificate, is made annually by the association to the individual judged to have made the most outstanding contribution to advancement of the gas industry.

▸ **C. D. Springer** is the new district foreman at Paola, Kansas, for Panhandle Eastern Pipe Line Company. He succeeds **H. D. Williams,** deceased. Springer is a 15-year man with the company.

▸ **Nelson Lee Smith,** of New Hampshire, has taken oath of office for a new term as a member of the Federal Power Commission. Commissioner Smith has been a member of the Federal Power Commission since October, 1943. He served as vice chairman in 1946 and as chairman from 1947 until May, 1950. His term expires in 1955.

A former member of the faculties of Dartmouth College and the University of Michigan, Smith served eight years as a member and chairman of the New Hampshire Public Service Commission. We went to Washington in 1941 as Chairman of the Board of Investigation and Research.

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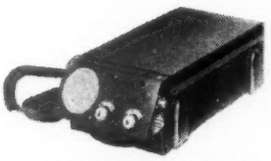

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PIPE LINE PROJECTS

2175-Mile Line Texas To Pacific Northwest

Pacific Northwest Pipeline Corporation has applied to the Federal Power Commission for authorization to construct a 2175-mile pipe line system from southern Texas to the State of Washington in order to bring natural gas to the Pacific Northwest for the first time. Robert R. Herring, Houston, Texas, is president of the corporation.

The proposed project, estimated to cost $174,186,602, would link the Texas gas reserve areas with gas fields in Alberta, Canada, to meet the requirements of the Pacific Northwest markets, including Vancouver.

The application says the main 26-in. Texas-to-Washington line would have an initial delivery capacity of 250,000,000 cu ft a day. The company also proposes to purchase approximately 100,000,000 cu ft daily at or near the U.S.-Canadian international boundary between Idaho and Canada through a lateral line extending from a point on the proposed main line northeasterly to Eastport, Idaho.

In addition to the main 2175-mile, 26-in. line, the company would build approximately 400 miles of 22-in. and lesser size lateral lines necessary for the gathering, distribution, and sale of the gas. Total installed compressor horsepower of the main line would be 83,200, or 13 stations of 6400 hp each.

The proposed main pipe line system would originate in the Wharton County, Texas, area and would extend through Texas, Oklahoma, Kansas, Colorado, Wyoming, Idaho, Oregon, and Washington, terminating in a sales area near Seattle and Tacoma, Washington, and Portland, Oregon.

The company states it would be able to supply gas to the Vancouver sales area by extending its line northward, and that it also plans to supply gas to the Atomic Energy Commission's plants near Arco, Idaho, and Hanford, Washington.

The application points out that the 100,000,000 cu ft per day of natural gas to be exported from Alberta is equal to the amount required to meet the ultimate needs of the Vancouver market, which actually places the Alberta Government in the position of supplying a Canadian market.

Susquehanna Announces 125-Mile Products Line

Construction is scheduled to begin about August 1 on an 8-in., 125-mile petroleum products pipe line from Sun Oil Company's Toledo, Ohio, refinery to Sarnia, Ontario, it was announced by William C. Kinsolving, president of the Susquehanna Pipe Line Company, a Sun Oil affiliate.

The route has been surveyed and the construction contract has been let to H. L. Gentry Construction Company, of Jackson, Michigan. The line is scheduled for completion and operation by about December 1.

Kinsolving said the new line will be operated as part of the Susquehanna system to deliver gasoline and furnace oils to Sun's River Rouge, Michigan, terminal and carry liquefied gases to a Canadian chemical plant at Sarnia.

Running north out of Toledo to Detroit, then northeast from the south of Pontiac, Michigan, the line will cross the St. Clair River at Marysville, Michigan, and then to Sarnia on the Canadian side.

The Marysville crossing will be from 45 to 50 ft deep, with the line laid 12 ft below the stream bed to safeguard against damage from the anchors of lake vessels.

A pump station powered by a 400-hp electric motor will move the products through the line at a maximum rate of 600 bbl an hr or about 14,000 bbl a day.

Propose Connecting Pipe Lines for Gas

New York State Natural Gas Corporation, of New York City, and The East Ohio Gas Company, of Cleveland, Ohio, have filed applications with the Federal Power Commission proposing to construct connecting pipe lines in Pennsylvania and Ohio, which would make additional natural gas available to East Ohio during the winter months.

New York State Natural plans to build a 20-in. line, approximately 63 miles long, extending from Westmoreland County, Pennsylvania, to a point on the Pennsylvania-Ohio state line where it would connect with a 1-mile, 20-in. line to be built by East Ohio in the Petersburg, Ohio, area.

Large Diameter Crude Oil Line Wood River to Lima

The Ohio Oil Company, Findlay, Ohio, which operates a common carrier system of multiple crude oil pipe lines between Wood River, Illinois (St. Louis area), and the Ohio-Pennsylvania state line, is planning construction of a new large diameter crude line between Wood River and Lima, Ohio, O. F. Moore, manager of the pipe line department announced.

The new line will replace existing lines, many of which have been in operation for more than 40 years. It is to be built of 20 and 22-in. steel pipe and will be coated and wrapped.

Construction is to begin the latter part of this summer, and it is expected that approximately 226 miles of line extending from Wood River to the company's Harlos Gate Plant, near Sheridan, Indiana, will be in operation before the end of the year.

At Harlos Gate Plant the new line will tie into the company's existing facilities to furnish transportation to Lima and other eastern points pending completion of the new line into Lima. Bechtel Construction Company will build one spread of 54 miles of the new line and Conyes Construction Company will build the remaining two spreads of 74 and 98 miles.

At its western terminus, Wood River, the new line will be available to receive shipments of crude oil from lines of other carriers moving oil from the Mid-Continent, Gulf Coast Texas, and Rocky Mountain producing fields. It will be routed via Patoka, Illinois, where shipments can be taken into the system from any of several pipe line junctions near that point.

From Patoka the line will extend to Martinsville, Illinois, and connect with other existing pipe lines owned and operated by the company. From there it will continue eastward through Indiana and Ohio, following generally the route of present lines. An emergency river crossing under the Wabash River will be installed to assure uninterrupted service.

The new line when completed will be the only big inch crude line between the St. Louis area and Lima, and will afford shippers modern pipe line transportation on both an interstate and an intrastate basis.

ANSWERS TO *OUR* QUESTIONS ABOUT NO-OX-ID RUST PREVENTIVES

● Here are the high points of a discussion recently held between a Dearborn representative, who *asked* the questions and an executive engineer of a major gas line who supplied the *answers:*

Q. How long have you used NO-OX-ID? **A.** Ten years.

Q. Uninterruptedly? **A.** Yes.

Q. Have you ever been disappointed? **A.** Certainly not, the results have been good.

Q. Can you name a specific performance? **A.** Yes, 10 years without a leak or replacement with soil resistance at 750 to 1200 ohms per cubic centimeter.

Q. What protection did you use prior to NO-OX-ID and what was your experience? **A.** Another coating that gave us an average pipe life of two years.

Q. Comparatively speaking, have you found NO-OX-ID applications cost less? **A.** Yes, not only with maintenance crews but some contractors on "big inch" lines have bid an average of five cents per foot less.

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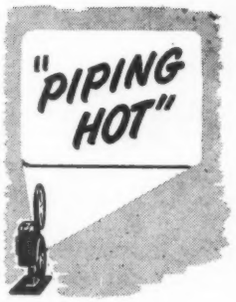

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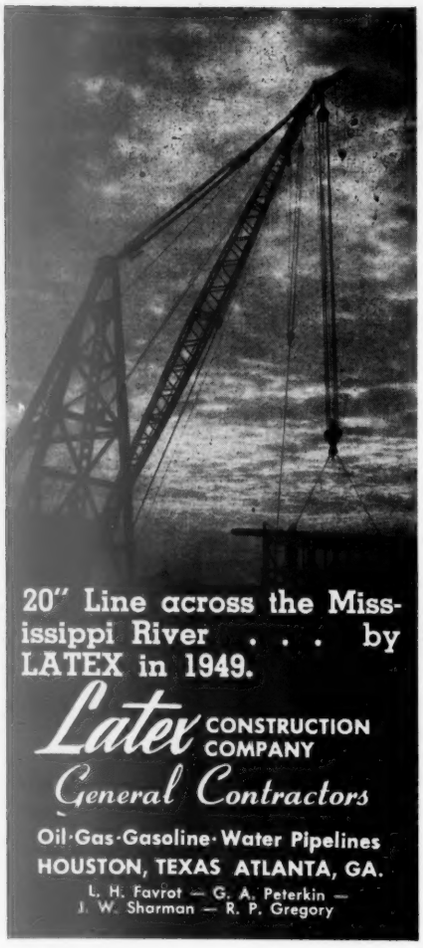
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Plans for Gas to California Approved

The Federal Power Commission has authorized El Paso Natural Gas Company, of El Paso, Texas, and Pacific Gas and Electric Company, of San Francisco, California, to construct pipe line facilities that will carry approximately 150,000,000 cu ft of natural gas per day from the Permian and San Juan Basins to markets in California, including the San Francisco area.

El Paso will construct a 451-mile line from the San Juan Basin to a connection with its existing system near the Arizona-California border in Mohave County, Arizona. The 150,000,000 cu ft of gas will be delivered to Pacific at a point near Topock, Arizona. In addition, El Paso will sell and deliver 17,000,000 cu ft daily to Southern Union Gas Company for resale in the towns of Winslow, Flagstaff, Williams, Prescott, Kingman, Seligman and Holbrook, Arizona, and Gallup, New Mexico.

Pacific Gas and Electric was authorized to install 32,160 additional compressor horsepower on its authorized Topock (Arizona)—Milpitas (California) pipe line in order to increase its allowable take from El Paso of out-of-state gas from 250,000,000 to 400,000,000 cu ft daily.

Total estimated cost of the El Paso project is $44,500,000, and the additional facilities to be built by Pacific are estimated to cost $7,800,000.

Facilities to Deliver Gas to Storage Sought

United Fuel Gas Company, of Charleston, West Virginia, is seeking Federal Power Commission authorization for the construction of approximately 5.5 miles of pipe line and three compressor stations with a total horsepower of 6460 to be used for delivering natural gas to storage pools in West Virginia.

The company would build about 3.5 miles of line extending from its Kanawha compressor station near Nitro, West Virginia, to an existing line serving United's Storage Pool X-15. A 2-mile line would connect with Tennessee Gas Transmission Company's line near Hunt, West Virginia, and extend northward to United's Hunt compressor station. This line would be used to transport gas received from Tennessee Gas for injecting into Storage Pool X-54, which United plans to activate starting in the summer of 1950.

The application says an 880-hp compressor station would be built in Storage Pool X-54, north of Hunt, for compressing the gas received from Tennessee to pressures required for injection into the pool. A 300-hp compressor station, to be located in United's Storage Pool X-8, would be used to inject and withdraw additional volumes of gas into and from the company's Storage Pools X-7 and X-8, and a 5280-hp station, in Storage Pool X-52, near Coco, West Virginia, would be used for injections and withdrawals at Pool X-52.

Estimated total capital cost of the proposed facilities is $2,464,800.

FPC Reopens Proceedings Involving Gas Companies

The Federal Power Commission has reopened the proceeding involving proposals to build natural gas pipe line facilities in the South and has scheduled further hearings to begin September 25 in Washington, D. C.

The proceeding involves applications of Atlantic Gulf Gas Company, Southern Natural Gas Company, and United Gas Pipe Line Company. Atlantic and Southern Natural both are proposing to serve substantially the same areas of Georgia, Florida, South Carolina, and Alabama. United would supply gas to Atlantic.

In reopening the proceedings, the FPC pointed out that on May 26 it ordered the presiding examiner to certify to the commission the entire record in the proceedings so as to enable the FPC to determine appropriate future procedure in the proceedings in accordance with the commission's rules.

The commission found that "it is appropriate and in the public interest to reopen the . . . proceedings to permit each of the parties . . . to introduce such further evidence as it deems appropriate on all issues in support of each respective application. . ."

Hearings on the applications were concluded February 15 in Washington, D. C., and final briefs were filed May 17.

Central Kentucky System Authorized to Expand

The Federal Power Commission has authorized Central Kentucky Natural Gas Company, of Charleston, West Virginia, to construct pipe line and compressor facilities to carry additional natural gas to its wholesale customers in the Cincinnati, Ohio, market area.

The newly-authorized facilities include approximately 41 miles of 20-in. loop pipe line extending from North Means to Foster, Kentucky. In addition, the company proposes to install one 880-hp gas-engine-driven compressor unit at its North Means compressor station.

PROJECTS

Compressor Increase Temporarily Granted

The Federal Power Commission has granted temporary authorization to Cities Service Gas Company, of Oklahoma City, Oklahoma, to install 3000 hp in additional compressor capacity at an existing station and to construct a new 690-hp station in order to increase the amount of natural gas that may be withdrawn from storage fields in Kansas.

The company will add three 1000-hp gas engine driven compressor units and appurtenant facilities at its existing North Welda station, in Anderson County, Kansas, to inject and withdraw gas from the North and South Welda storage fields. Cities Service said that installation of these facilities will increase the amount of gas which may be withdrawn from these storage fields by 35,000,000 cu ft daily.

The new compressor station, to be situated in Johnson County, Kansas, will consist of three 230-hp gas engine driven compressor units and appurtenant facilities. The station will be utilized to withdraw gas from the company's Craig storage field for delivery into the main line against the high pressure presently carried in order to meet peak-day requirements.

Cities Service plans to abandon its South Welda station in Anderson County, using compressor units reclaimed from this station for installation in the new Johnson County station.

The total estimated cost of the project is $885,000.

Expansion Authorized of Michigan-Wisconsin Line

The Federal Power Commission has issued an opinion and order granting final authorization for the construction of facilities designed to nearly double the present capacity of Michigan-Wisconsin Pipe Line Company's Texas-to-Michigan natural gas pipe line system.

The authorization involves two companies, Michigan-Wisconsin and Michigan Consolidated Gas Company, both of Detroit, Michigan, and subsidiaries of American Natural Gas Company. The companies received temporary authorization for the construction on June 28.

The construction program will increase the annual sales capacity of the line from 56,575,000,000 cu ft to a new total of 110,595,000,000 cu ft. Daily sales capacity will be increased from 155,000,000 to 303,000,000 cu ft.

In a concurrent opinion and order, supplemental to the FPC's opinion and order of August 2, 1949, which authorized the construction of facilities to provide a total capacity of 155,000,000 cu ft per day on the system, the commission authorized Michigan-Wisconsin to lease from Michigan Consolidated and operate existing and proposed storage facilities in the Austin and Goodwill fields in Michigan.

The newly-authorized expansion program involves the installation of 139,200 hp of additional compressor capacity by Michigan-Wisconsin. The line now has an authorized capacity of 29,600 hp. Estimated cost of the Michigan-Wisconsin project is $22,732,000.

Michigan Consolidated will install facilities to provide additional storage capacity required in connection with Michigan-Wisconsin's expansion plans. Overall capital cost of these facilities is estimated at $15,346,500.

Underground Storage Facilities Approved

The Federal Power Commission has authorized The East Ohio Gas Company, of Cleveland, Ohio, to construct and operate underground natural gas storage facilities in northeastern Ohio. The construction program includes two 8⅝-in. lines totaling 12.3 miles in length; a 940-hp compressor station, and an underground gas storage pool consisting of 13 wells and 3500 acres of gas storage leaseholds in Columbiana County, Ohio. Estimated cost of the project is about $622,700.

The company plans to operate the pipe lines solely for the purpose of storing gas in the underground storage pool during off-peak periods and for transporting the gas into its general system during periods of peak demand. The storage facilities are estimated to have an ultimate capacity of approximately 2,400,000,000 cu ft with an approximate daily delivery capacity of 33,000,000 cu ft.

Tennessee Natural Will Expand Facilities

Tennessee Natural Gas Lines, Inc., of Nashville, Tennessee, has received Federal Power Commission authorization to expand its pipe line facilities in order to increase natural gas deliveries to Nashville Gas and Heating Company for distribution in the Nashville area.

Tennessee Natural's proposed project will include approximately 24 miles of pipe and the necessary regulator and meter stations in the Nashville vicinity. The additional facilities will increase the company's delivery capacity, now approximately 28,000,000 cu ft a day, to more than 41,000,000 cu ft.

Texas Gas to Add 9960 Compressor Hp

Texas Gas Transmission Corporation, of Owensboro, Kentucky, is seeking Federal Power Commission authorization for the installation and operation of 9960 hp in compressor capacity at existing and new stations on its system in order to transport additional quantities of natural gas for Texas Eastern Transmission Corporation, of Shreveport, Louisiana.

The proposed construction program includes the installation of 5460 additional hp at four existing stations in Tennessee and Kentucky, and construction of a new 4500-hp station in Kentucky. Estimated cost of the project is $2,108,887.

The application says that the additional capacity would enable Texas Gas to transport for Texas Eastern (1) up to 60,000,000 cu ft of natural gas per day between November 1, 1950, and November 1, 1951, and (2) up to 34,000,000 cu ft per day from November 1, 1951, to November 1, 1952, or until Texas Eastern completes new facilities proposed in an application now pending before FPC (Docket No. G-1012).

Texas Gas would transport the gas for Texas Eastern from an existing connection between facilities of the two companies near Lisbon, Louisiana, to another connection near Lebanon, Ohio.

Texas Eastern's pending application (in Docket No. G-1012) seeks FPC authorization for the expansion of the daily sales capacity of its system to furnish additional natural gas to its present customers and to supply Algonquin Gas Transmission with gas for resale in New England.

United Gas Pipe Line Plans New Facilities

United Gas Pipe Line Company, of Shreveport, Louisiana, has applied to the Federal Power Commission for authorization to construct approximately 16 miles of pipe line, a compressor station, and a dehydration plant in Louisiana in order to augment the supply of natural gas to its existing customers.

The proposed 16-mile, 16-in. line would extend from United's Koran gasoline plant site, in Webster and Bossier parishes, Louisiana, to its Carthage (Texas)-Sterlington (Louisiana) line in Bienville Parish, Louisiana. A 4000-hp compressor station and the dehydration plant would be installed near the northern terminus of the proposed new line. Daily capacity of the facilities would be about 100,000,000 cu ft of natural gas, the application states.

United Asks to Lay 1130 Miles of Line

United Gas Pipe Line Company has filed an application with the Federal Power Commission proposing the construction of 1130 miles of natural gas pipe lines in Texas, Louisiana, and Mississippi. Cost of the proposed pipe lines and other facilities was estimated to be in excess of $111,000,000.

The project will receive its supplies of gas from substantial reserves in a number of fields along the Texas and Louisiana Gulf Coasts. Construction of these facilities will provide an initial increase in the capacity of United's pipe line system of approximately 805,000,000 cu ft daily.

These enlarged facilities would serve the triple purpose, according to the application to the FPC, of increasing the flexibility of the United Gas system, providing it with new and substantial additional reserves of natural gas, and obtaining a more balanced distribution of reserves now connected. United Gas serves more than 400 cities and towns in Texas, Louisiana, Mississippi, southern Alabama, and northwestern Florida.

The proposed lines would constitute a major addition to the existing United Gas system, augmenting the delivery capacity of the system to meet the increased demands of present customers as well as to serve new customers in the area, according to the application. Deliveries would be made to cities, towns and industrial plants along the lines, as well as to Texas Eastern Transmission Corporation and other pipe line companies.

Columbia Subsidiaries File Joint Application

Four subsidiary companies of The Columbia Gas System, Inc., have filed a joint application with the Federal Power Commission asking authorization to make additions to their natural gas transmission systems in Ohio, West Virginia, Pennsylvania, and New York. Total estimated net cost of all the projects is $1,664,570.

The four subsidiaries are The Manufacturers Light and Heat Company, Cumberland and Allegheny Gas Company, Natural Gas Company of West Virginia, and Home Gas Company, all with main offices in Pittsburgh, Pennsylvania.

Only one of the four projects, Home Gas Company's, involves the sale of gas to a new territory. The other three companies would use the proposed facilities to provide continuous service to existing customers and to provide for normal growth within the territories presently served by them.

Manufacturers is proposing to construct approximately 44 miles of pipe line ranging from 4 to 16 in. in diam at various points on its system in Ohio, Pennsylvania, and West Virginia, and to install two additional 500-hp compressor units and dehydration equipment at an existing compressor station. In addition, Manufacturers plans to retire a total of about 7.8 miles of line and an aggergate 970-hp in compressor units in Pennsylvania.

Natural Gas Company of West Virginia is seeking authorization to build about 4.5 miles of 4, 6, and 8-in. line in Ohio. The Cumberland and Allegheny project involves the construction of 10.3 miles of 6 and 8-in. line and a 65-hp compressor station in West Virginia.

Home Gas Company would install a meter and regulating station in Rockland County, New York, for the purpose of selling gas to Rockland Gas Company, Inc.

New Compressor Station For Arkansas Louisiana

The Federal Power Commission has authorized Arkansas Louisiana Gas Company, of Shreveport, Louisiana, to install a new 7000-hp compressor station on its natural gas pipe line system near Blanchard, Louisiana.

The station, estimated to cost $1,507,000, will enable the company to transport gas produced in Louisiana and Texas gas fields to additional retail customers in central Arkansas and to make additional volumes of gas available to presently connected customers in Arkansas at required pressures.

Initial installation of three 1400-hp units, for a total of 4200 hp, will give the station a capacity to compress 65,400,000 cu ft daily. The remaining two units are expected to be installed before the 1951-52 heating season, bringing the capacity of the station up to 109,000,000 cu ft daily.

Cities Service Gas Withdraws Application

The Federal Power Commission has permitted Cities Service Gas Company, of Oklahoma City, Oklahoma, to withdraw its application proposing (1) the construction of approximately 42.6 miles of natural gas pipe line and (2) the abandonment of about 127.3 miles of line, all in Kansas.

The company filed a notice of withdrawal on June 28, stating that construction requirements of an emergency nature elsewhere on its pipe line system during the current year required that consideration of the projects in the application be deferred.

Jersey Central Permitted Added Gas Volume

The Federal Power Commission has amended an earlier order to permit Jersey Central Power and Light Company, of Asbury Park, New Jersey, to transport additional volumes of natural gas through its pipe line facilities for delivery to its electric generating station at Sayreville, New Jersey.

Jersey Central last February 10 applied to the FPC for authority to build a 7-mile pipe line from its existing system to the electric power plant, but the commission dismissed that application for lack of jurisdiction and found that the company's natural gas facilities could be used only for the purposes authorized in an FPC order of September 27, 1949.

The 1949 order authorized Jersey Central to construct natural gas transmission facilities extending from a connection with Texas Eastern Transmission Corporation's line to Jersey Central's gas manufacturing plant at Long Branch, New Jersey, where the natural gas was to be transformed or mixed with manufactured gas for subsequent local distribution.

Following the dismissal of the February 10 application, Jersey Central filed a petition to modify the 1949 authorization to permit the transportation of the additional gas on an interruptible basis for the power plant.

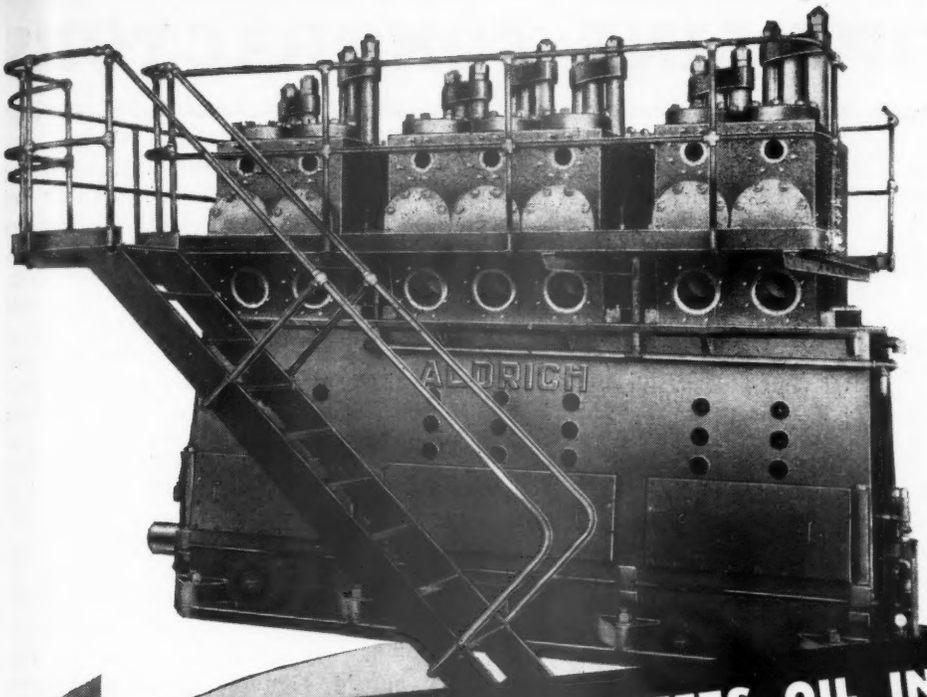
Mississippi River Lines Needed at Greenville

Texas Gas Transmission Corporation of Owensboro, Kentucky, has applied to the Federal Power Commission for an emergency certificate authorizing the construction of two 20-in. submarine pipe lines across the Mississippi River.

The company said the new lines are required because of the failure during the early spring of 1950 of four of its submarine pipe line crossings under the Mississippi in the Greenville area. This failure has caused an excessive pressure drop at the river crossing, which results in a serious decrease in capacity of its two systems, Texas Gas said.

In addition to the submarine lines, each about 3.4 miles long, the company would build 1.93 miles of 26-in. pipe line to interconnect the submarine lines both with the 18-in. pipe line system and its 26-in. system. Estimated cost of the construction is $1,457,959.37, the application states.

Texas Gas, which operates pipe line facilities extending from Texas eastward to Ohio, proposes to begin construction of the underwater lines not later than September 1, 1950.



This 8½" stroke, 1900 hp Inverted Septuplex Pump was made for crude oil pipe line service and is designed for direct coupling to engine, motor or speed reducer. Illustration shows pump without suction and discharge manifolds. Request Data Sheet 67.

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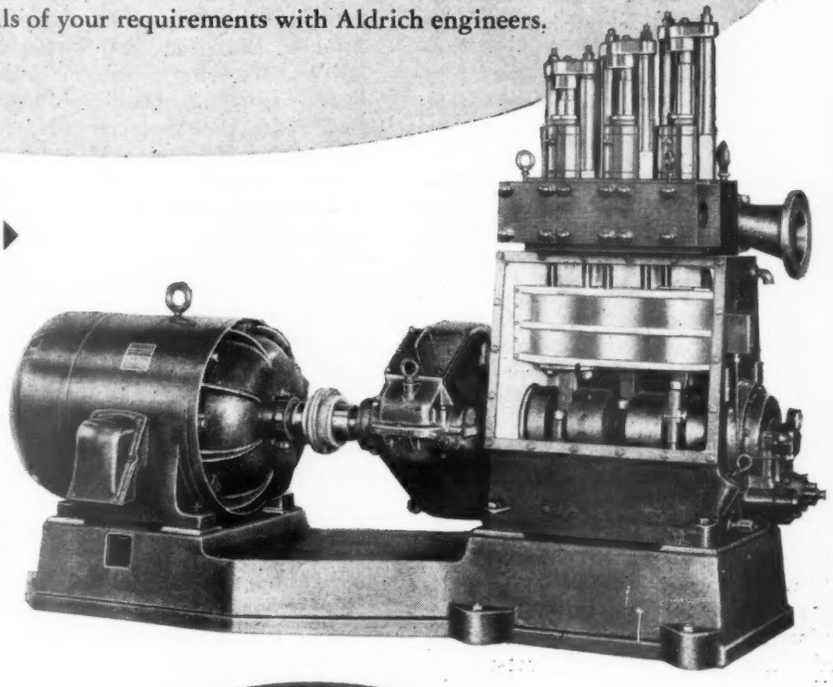

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With the PIPE LINE CONTRACTORS

Price-Morrison, 311 East Eleventh Street, Austin, Texas, have a general contract covering construction of 174 miles of 30-in. high pressure natural gas pipeline for Tennessee Gas Transmission Company in western Tennessee and Kentucky. This is a joint venture between Price Constructors, Inc., Bartlesville, Oklahoma (sponsor), and Morrison Construction Company, Inc., Austin, Texas. Work was approximately 20 per cent completed as of July 10. Spreads are located as follows:

Dickson, Tennessee: Jack Hodges, superintendent; A. G. Goyne, office manager; Dick Rash, R-O-W foreman; Red Wright, ditch foreman; Ralph Farrar, pipe foreman; Harry Ebers, welding foreman; Cowboy Tatom, dope foreman; Frank Coleman, bending foreman; E. E. Wilkerson, lowering in foreman; Willie Sullivan, clean-up foreman, and Jack W. Bradfield, crossing foreman.

Franklin, Kentucky: R. L. McMillon, superintendent; E. J. Price, office manager; W. K. Stowell, R-O-W foreman; John Dyer, ditch foreman; Rex Pickens, pipe foreman; Ab Campbell, welding foreman; Rip Vann, dope foreman; Ray Huston, bending foreman; Leon Pharris, lowering in foreman; G. B. Whitehead, clean-up foreman, and J. L. Hodge, double-joint foreman.

Brown and Root, Inc., 4100 Clinton Drive, Houston, Texas, were awarded the contract by Pan American Pipe Line Company to lay 80 miles of 10-in. from Scurry County, Texas, through Mitchell, Sterling, Tom Green, and Irion counties. The contractor also will build an 800-hp compressor station north of Colorado City, Texas.

H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, is working on a general contract covering construction of 373 miles of 26-in. high pressure natural gas pipe line for Tennessee Gas Transmission Company from the north bank of Ohio River east of Portsmouth, Ohio, northeastward to near Buffalo, New York. Work on initial section of nearly 220 miles through Ohio was approximately 85 per cent completed as of July 10. Work in Pennsylvania and New York began the latter part of July. The entire line is to be ready for operation by late fall. Spreads are located as follows:

Carrollton, Ohio: G. A. Reutzel, superintendent; W. E. Yount, office manager; J. A. Hairston, R-O-W foreman; L. J. Loncarich, ditch foreman; J. C. Anderson, bending foreman; H. C. Morrison, pipe foreman; K. N. Adkins, pipe foreman; R. W. Orr, welding foreman; S. J. Wood, coating foreman; A. L. Bell, lowering in foreman, and T. E. Walker, clean-up foreman.

Athens, Ohio: W. B. Williams, superintendent; P. O. Rutledge, office manager; R. H. Edwards, R-O-W foreman; K. K. Kelly, ditch foreman; Roy Stegall, bending foreman; J. I. Cobb, pipe foreman; C. F. Jones, welding foreman; Rube Owens, coating foreman; A. D. Hamilton, lowering in foreman, and Fred Williams, clean-up foreman.

Cambridge, Ohio: R. K. Shivel, superintendent; R. E. Burgess, office manager; J. D. White, R-O-W foreman; W. H. Olrich, ditch foreman; J. H. Latham, bending foreman; C. E. Shivel, pipe foreman; R. L. Ezell, welding foreman; U. M. Beaver, lowering in foreman; Sam Price, clean-up foreman, and Ray Drewell, crossing foreman.

Jackson, Ohio: C. R. Ice, superintendent; G. A. Harvey, office manager; John E. Hamilton, R-O-W foreman; E. W. Whisenant, ditch foreman; Forest Loinette, bending foreman; Jack Smith, pipe foreman; L. O. Reutzel, welding foreman; N. D. Adams, coating foreman; J. C. Rich, lowering in foreman, and E. D. Worley, clean-up foreman.

Texas-Southern Contracting Company, 804 Dan Waggoner Building, Fort Worth, Texas, has laid 10 miles (July 24) of Transcontinental Gas Pipe Line Corporation's line between Deweyville and Porters, Texas, the section being 92 miles of 30-in. The field office and warehouse are at Liberty. Merle Tatom is spread man and Lee Price office manager.

Equipment is being moved in to make underwater crossings of the Trinity River near Liberty and the Sabine River near Deweyville. The crews will work out of the Liberty office. "Borger Red" McMenamy will be spread man for one of the crossings, perhaps both.

In Louisiana, 50 miles of 18 and 20-in. are being laid for Transcontinental near Eunice. The 20-in. has been completed and laying of the 18-in. began July 24. The field office is at Crowley. Jimmy Reid is spread superintendent and Pat Rogan office manager.

R. H. Fulton and Company, Box 1526, Lubbock, Texas, is about half completed with the laying of 222 miles of 26-in. loops between Borger, Texas, and the Nebraska state line for Northern Natural Gas Company. The field office has been at Ashland but will be moved to Greensburg and Minneapolis, Kansas. For the same company, 155 miles of 20-in. is being laid from Garden City to Bushton, Kansas. The work is in progress with the field office at Garden City. It will be moved to Jetmore, Kansas, however.

Two spreads are at work for Transcontinental Gas Pipe Line Corporation, installing 202 miles of 30-in. between Spartansburg, South Carolina, and Chatham, Virginia. One spread is working out of Winston Salem, North Carolina, and the other out of Danville, Virginia. This work is approximately 70 per cent completed.

The company also has contracted to lay 184 miles of 26-in. in Mississippi, Tennessee, and Kentucky for Trunkline Gas Supply Company. This work was scheduled to begin August 1. Beginning about September 1, 278 miles of 20-in. will be laid for Trunkline in the Rio Grande Valley area of Texas.

J. L. Cox and Son, Raytown, Missouri, (stringing contractors), are stringing 232 miles of 16, 18, and 24-in. pipe for Sheehan Pipe Line Construction Company in Georgia, Alabama, and Mississippi. This is on the Southern Natural Gas Company line. Fred Osterman and Lionel Pugh are the foremen.

For O. R. Burden Construction Company (Texas-Empire Pipe Line Company), 44 miles of 16-in. are being strung between Wilmington, Illinois, and Dyer, Indiana. J. R. Lyerla is foreman. For Brown-Lite Company (Great Lakes Pipe Line Company), 43 miles of 12-in. between Kansas City and Atchison, Kansas. Fred Osterman is foreman.

H. L. Gentry Construction Company, 921 Michigan Avenue, Jackson, Michigan, has been awarded a contract by the Susquehanna Pipe Line Company to lay a products pipe line from Sun Oil Company's Toledo, Ohio, refinery to Sarnia, Ontario, Canada. This line will be 125 miles long and of 8-in. diam. Construction was scheduled to begin August 1 and the line completed about December 1.

The contractor is also laying 90 miles of 22-in. for Mid-Valley Pipeline Company between Mt. Washington and Hebron, Kentucky.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors), will string the 415-mile, 24-in. line, known as the San Juan line, for El Paso Natural Gas Company. The gas company does its own construction work. The line will be from Fruitland, New Mexico, to a point near Yucca, Arizona.

Other jobs under way are as follows:

H. C. Price Company (Tennessee Gas Transmission Company), 400 miles of 26-in. in Ohio, Pennsylvania, and New York.

Conyes Construction Company (Montana-Dakota Utilities Company), 340 miles of 12-in. in Wyoming and Montana.

El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Britton Construction Company (Tennessee Gas Transmission Company), 35 miles of 16-in. in Pennsylvania.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, is laying the 340-mile, 16-in. section of Interprovincial Pipe Line Company's system between Regina, Saskatchewan, and Gretna, Manitoba. Overall the Interprovincial system will extend from Edmonton, Alberta, to Superior, Wisconsin, from where the crude oil will be transported to Sarnia, Ontario, by lake tanker. The contractor has three spreads at work under the supervision of "Whitey" Martin, Clyde Gregory, and "Pee Wee" Petty.

The Transcontinental Gas Pipe Line Corporation job is making good progress. This consists of 86 miles of 30-in. between Danielsville, Georgia, and the Saluda River in South Carolina.

Midwestern Constructors, Inc., 105 North Boulder Street, Tulsa, Oklahoma, has contracted to lay four schedules and install a river crossing for Texas Illinois Natural Gas Pipeline Company. Schedule 1 will consist of approximately 100 miles of 26-in. between LaGloria and Refugio, Texas, beginning September 1. Schedule 11 will be 100 miles of 30-in. from the Mississippi River to Effingham, Illinois. This work is scheduled to begin about September 15. Schedule 12 will consist of approximately 117 miles of 30-in. between Effingham and Sibley, Illinois. This work will not be done until in 1951, as will Schedule 13, which is 92 miles of 30-in. from Sibley to Joliet, Illinois. An underwater crossing will be made of the Illinois River near Morris, Illinois.

The contractor is now engaged in laying 43.4 miles of 26-in. between Palmyra, Nebraska, and Oakland, Iowa, for Northern Natural Gas Company. R. C. Stanley is superintendent. The field office is at Glenwood, Iowa. When this section is completed, work will begin on 65.9 miles of 26-in. extending northeastward from Oakland. Additions are being made to two of Northern Natural's compressor stations, at Palmyra and Beatrice, Nebraska. Lyle S. DeWitt is superintendent at the former and J. A. Bard at the latter. Both are about 20 per cent completed.

For Southern California Gas Company and Southern Counties Gas Company of California, 83 miles of 30-in. are being laid near Riverside. This contract is a joint venture with **Johnson Western Gunite Company** and **L. E. Dixon Company** of Los Angeles. The field office is at Riverside, and the work is about 70 per cent completed.

Except for the Hugoton loop, 69 miles of 26-in. loop lines have been installed for Panhandle Eastern Pipe Line Company between Olpe and Hugoton, Kansas. M. T. Wilhite is superintendent, the spread working out of Liberal.

Trojan Construction Company, Box 4427, Oklahoma City, Oklahoma, is taking up 190 miles of 10-in. pipe that was formerly owned by Shell Pipe Line Corporation. The line extends eastward from Springfield, Missouri. Maurice W. Crawford is superintendent and Don Wilson office manager. Twenty-five miles had been taken up July 20.

O. R. Burden Construction Corporation, Box 5216, Tulsa, Oklahoma, completed two jobs the middle of July, one for Mid-Valley and the other for Texas-Empire. The Mid-Valley Pipeline Company project was 63 miles of 20-in. between Longview, Texas, and Dixie, Louisiana. B. C. Hall was the spread man with E. E. Haworth manager of the field office, which was at Marshall, Texas. For Texas-Empire Pipe Line Company, 43.5 miles of 16-in. was laid from Wilmington, Illinois, to East Chicago, Illinois. O. P. Hiner was spread man, with the office at Chicago Heights, Illinois.

Reese Brothers Construction Company, Hugoton, Kansas, is installing on an 85-mile gathering system for Northern Natural Gas Company, working out of Garden City, Kansas. The pipe diameter is 4, 6, 8, and 12-in. Paul Reese is general superintendent, Edd Reese spread man, Gale Reese welding foreman, and Chet Beighle office manager.

Mahoney Contracting Company, Hersee Building, Mt. Pleasant, Michigan, was scheduled to begin construction August 1 of 186 miles of 26-in. between Tuscola and Joppa, Illinois, for Trunkline Gas Supply Company.

Right-of-way clearing operations have started between St. Johns and Marion, Michigan. For Michigan Gas Storage Company, 84 miles of 22-in. will be laid between these two points.

The 31 miles of 26-in. being laid from Wauseon, Ohio, to Monroe, Michigan, for Panhandle Eastern Pipe Line Company was 50 per cent completed July 24. River crossing work at Grand Haven, Michigan, for National Utilities Corporation was being completed.

The 120-mile section of Mid-Valley Pipeline Company's system between the Ohio River and Lima, Ohio, has now been finished.

Holdren Construction Company, P.O. Box 417, Mount Vernon, Illinois, is installing a city distribution system for Illinois Power Company at Columbia, Illinois. The system will consist of 12,000 ft of 4-in., 30,000 ft of 2-in., and 16,000 ft of $1\frac{1}{4}$-in.

Associated Pipe Line Contractors, Inc., 3272 Westheimer, Houston, Texas, is laying 84 miles of 18-in. for Portland Pipe Line Corporation as a part of the system that will parallel an existing 12-in. line. The section is between Gorham, New Hampshire, and the Canadian border. Lacy Walker is spread superintendent.

This contractor is also laying 75 miles of 30-in. pipe for Transcontinental Gas Pipe Line Corporation from Rockville, Maryland, to Conawingo, Pennsylvania. The field office is at Towson, Maryland.

For Mid-Valley Pipeline Company, 111 miles of 22-in. crude oil line are being laid from Mayersville to Holly Springs, Mississippi.

Anderson Brothers Construction Company, 707 North Drennan Street, Houston, Texas, will lay 397 miles of the Trunkline Gas Supply Company system. Section B, on the main line, consists of 180 miles of 26-in. between Darnell, Louisiana, and Senatobia, Mississippi. Sections G and H are laterals and consist of 217 miles of 24-in. from Longville, Louisiana, to Altair, Texas.

Between Gretna, Manitoba, and Superior, Wisconsin, 360 miles of 18-in. are being laid for the Lakehead Pipe Line Company, associate of Interprovincial Pipe Line Company.

For Transcontinental Gas Pipe Line Corporation, 82 miles of 30-in. are being laid between Eunice, Louisiana, and a point near Deweyville, Texas.

Latex Construction Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

For Tennessee Gas Transmission Company, 101 miles of 30-in. gas line. Sixty-eight miles of this work is from the vicinity of West Monroe, Louisiana, to Natchitoches, Louisiana. W. H. Hayes is superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office; headquarters, Jonesboro.

For Tennessee Gas Transmission Company, 71 miles of 16-in. and 12-in. gas line, from Kinder, to Grand Chenier, Louisiana. F. A. Silar, superintendent; C. V. Oliver, office manager; headquarters, Kinder, Louisiana. The first 25 miles of this job, which is 16-in., has been completed. This spread began on the 12-in. with headquarters at Lake Charles, Louisiana, July 1. Another spread also started on the 12-in. section in the marsh July 1. The superintendent of the second spread is H. L. Leake; office manager, S. B. Harrison; headquarters, Lake Charles, Louisiana.

For Transcontinental Gas Pipe Line Corporation in South Louisiana, 85 miles of 4-in. to 14-in. gas gathering system. One spread has J. B. Latham as superintendent; W. M. Keller, office manager. Headquarters are at Jennings, Louisiana. The second spread has F. A. Silar as superintendent; C. V. Oliver, office manager; headquarters, Abbeville, Louisiana. The third spread is working out of Pecan Island, Louisiana, with J. A. Cantrell as superintendent and A. E. Stremmel, office manager.

For Tennessee Gas Transmission Company, 95 miles of 20-in. gas line, from Natchitoches, to Kinder, Louisiana. F. A. Silar is superintendent; C. V. Oliver, office manager; headquarters, Kinder, Louisiana.

For Tennessee Gas Transmission, 105 miles of 16-in. gas line, from Kinder, east to Bayou Sale, Louisiana.

Installation of one 16-in. temporary line on the Greenville, Missisippi River Bridge and the removal of one 18-in. line for Tennessee Gas Transmission Company. H. E. Murphy, superintendent; J. H. Mabry, office manager; headquarters, Lake Village, Arkansas. Work in progress.

Eastern Construction Company, 1801 Mercantile Bank Building, Dallas, Texas, which completed its 155-mile section for Mid-Valley Pipeline Company the early part of July, 50 days ahead of schedule, will now take on an additional 20 or 25 miles in Kentucky. Fred Byers is general superintendent and J. W. Arthur is managing the field office.

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, has completed 28 miles of the 85 miles of 18-in. it is laying for the Portland Pipe Line Company between Portland, Maine, and Gorham, New Hampshire (July 25). The field office has been moved from Westbrook to Norway, Maine. H. A. Wylie is superintendent and Lisle W. Chambers paymaster.

The 23 miles of 30-in. being laid for Transcontinental Gas Pipe Line Corporation between Edgewater and Elizabeth, New Jersey, is still in progress. The field office is at Harrison, New Jersey, with Pete Thurman superintendent and Joe Freeman paymaster.

The middle of August or first of September work is to begin on 80 miles of 26-in. for Transcontinental, to be laid from Refugio, Texas, south. The spread will be in charge of "Panama" Shiflett, who is now supervising work on 30 miles of 30-in. near Wharton, Texas, for Tennessee Gas Transmission Company. The Transcontinental job will begin as soon as the Tennessee work is completed.

In Mississippi, 91 miles of 30-in. are being laid for Tennessee Gas from Sunflower County to Marshall County. The field office is now at Batesville. Raymond Law is superintendent and Gene Gohring paymaster.

Canadian Bechtel, Ltd., and **Fred Mannix and Company, Ltd.,** Calgary, Alberta, Canada, as a joint venture, are working three spreads on Interprovincial Pipe Line Company's crude oil system between Edmonton, Alberta, and Superior, Wisconsin. The two companies are laying 441 miles of 20-in. from Edmonton to Regina. Overall length of the system is 1150 miles. The project office is in Room 416, Northern Hardware Building, Edmonton. E. W. Davis is project manager and Ralph Hamilton assistant project manager.

Ray L. Smith and Son, Inc., El Dorado, Kansas, are clearing the right-of-way to lay 104 miles of 18-in. pipe between Stanardsville and Richmond, Virginia, for Commonwealth Natural Gas Corporation. Don C. Smith will have charge of Spread No. 1 working out of Orange, Virginia. Phone No. 6001. Wm. G. (Bill) Frost will have charge of Spread No. 2 working out of Richmond. The warehouse is at 5606 West Broad Street on Highway 250. Ray Leigh Smith will be general superintendent.

In addition to the above, the contractor will lay 84 miles of 12-in., 20 miles of 8-in., and various laterals between Richmond and Newport News for Commonwealth Natural.

Smith Contracting Corporation, 1410 Fort Worth National Bank Building, Fort Worth, Texas, expects to complete Section 10 of Transcontinental Gas Pipe Line Corporation's system the first week in August. The field office is at Appomattox, Pennsylvania, with Jack Landers spread superintendent and Ben Mapes office manager. Work is progressing on Section 11. The two sections total 196 miles of 30-in. and extend from Chatham, Virginia, to the Potomac River. The Section 11 field office is at Charlottesville, Virginia, where C. C. Craig is spread superintendent and H. J. McAdams office manager.

The company has contracted to lay 108 miles of 16-in. for Texas Eastern Transmission Corporation between Baytown and Provident, Texas. The start of this job is still awaiting the arrival of pipe.

Parkhill Truck Company, P.O. Box 1856, Tulsa, Oklahoma, (stringing contractor), is now working on contracts as follows:

Lakehead Pipe Line Company (Anderson Brothers Construction Company, general contractor), 340 miles of 18-in. between Nechi, North Dakota, and Superior, Wisconsin.

Transcontinental Gas Pipe Line Corporation (Smith Contracting Corporation), 196 miles of 30-in. from the South Carolina border, to the Potomac River.

Mid-Valley Pipeline Company (Britton Construction Company), 108 miles of 22-in. between Russellville and Elizabethtown, Kentucky.

Salt Lake Pipe Line Company (Morrison-Knudsen Company, Macco Corporation, Bechtel Corporation), 120 miles of 8-in., Boise, Idaho, to Baker, Oregon.

Salt Lake Pipe Line Company (Pacific Pipeline and Engineers, Inc.), 120 miles of 6 and 8-in., Baker, Oregon, to Pasco, Washington.

Montana Power Company (Deaton and Sons, Inc.), 104 miles of 12-in., Bozeman to Butte, Montana.

Northern Natural Gas Company (Midwestern Constructors, Inc.), 109 miles of 26-in., Oakland to Holmes, Iowa.

Northern Natural Gas Company (R. B. Potashnick Company), 112 miles of 26-in., Holmes, Iowa, to Farmington, Minnesota.

Panhandle Eastern Pipe Line Company (Anderson Brothers Construction Company), 75 miles of 26 and 30-in. loop lines between Houstonia, Missouri, and Edgerton, Ohio.

Panhandle Eastern Pipe Line Company (Midwestern Constructors, Inc.,) 68 miles of 26-in. loop lines between Hugoton and Olpe, Kansas.

NEWS

Price Rise Noted Throughout Nation

Prices for heavy fuel oil, premium gasolines and high quality crude have been raised in most parts of the country in the past few weeks. The Texas Company raised its tankwagon price of regular and premium grade gasoline ½-cent a gallon, in all Texas market areas east of the Pecos River, making the second advance of the year for gasoline prices in Texas. New prices are 19½ cents a gallon for regular and 21½ cents for premium.

Esso Standard Oil raised its wholesale gasoline prices to service stations by amounts ranging from 0.2-cent a gallon to ½-cent from Maine to Louisiana. This increase follows a ½ cent a gallon hike by Socony Vacuum Oil in New York and New England last month. Esso spokesmen stated its refineries are operating at capacity and cannot buy enough high quality gasoline for its needs at the present price levels on an economics basis.

Gulf Oil Corporation followed Texaco's lead in Texas, raising its wholesale gasoline prices. Gulf's increase affected all grades. Premier Oil Refining Company in Fort Worth posted a ¼-cent advance, explaining that the increase was limited because of the lower octane rating of its gasoline.

The Joseph Seep purchasing agency of the South Penn Oil Company has announced that prices of Pennsylvania crude oil were raised 14 cents a barrel. George J. Hanks, president of South Penn Oil, said the demand by refiners for increased supplies of crude oil has steadily continued during the past month, resulting in a depletion of available stocks and has created "extremely tight supply position."

Out on the West Coast, Union Oil Company of California has announced an increase in the price of heavy fuel oil from $1.40 per barrel to $1.60 per barrel in Los Angeles.

Plans New Building

California Research and Development Company is planning to construct a steel frame building near Livermore, California. A subsidiary of California Research Corporation, this company was formed to direct a new research project for the U. S. Atomic Energy Commission at the site of the former Naval Air Station near Livermore.

Dinwiddie Construction Company of San Francisco has been announced as low bidder for construction of the building.

Demand Up 9.1 Per Cent For First Four Months

Total demand for all oils in the first four months of 1950 was up 9.1 per cent from the corresponding 1949 period according to Bureau of Mines figures. This rise is significant due to the fact that the figures were taken before the war in Korea was begun.

The overall demand amounted to 802,484,000 bbl. Domestic demand for the four principal refined products amounted to 683,896,000 bbl, an increase of 11.4 per cent from the like 1949 period. Gasoline demand at 289,361,000 bbl was up 29,947,000 or 11.1 per cent from the first four months in 1949. Domestic demand for kerosine totaled 46,629,000 bbl, a gain of 6,555,000 or 16.3 per cent.

Light fuel oil demand rose some 17.7 per cent, amounting to 154,300,000 bbl, the bureau reported, and domestic heavy fuel oil demand was up 12.2 per cent from the year earlier period. Demand for heavy fuel oil amounted to 193,606,000 bbl.

Caltex - U.K. Agree On Sterling Oil

Caltex has successfully concluded negotiations in London with the British Government under which Caltex oil refined at Bahrein from both Aramco and Bahrein crude oil for distribution only in the sterling area now qualifies as sterling oil.

Agreement has been reached with the British Government on a reduction of dollar cost elements of Caltex oil sold by Caltex (U.K.) Ltd. This agreement was facilitated partly by an arrangement under which Aramco can now accept substantial payments from Caltex (U.K.) Ltd. in sterling, and can use such sterling in current operations, and partly by Caltex using its sterling crude oil, which it produces at Bahrein, in mixture with the Aramco crude refined for Caltex (U.K.) Ltd. at Bahrein, and by the conversion of tanker freight to a sterling basis.

It was stated that this is an individual agreement between Caltex as a company and the British Government and it does not affect any discussions between the U. S. and British Governments on the sterling/dollar oil problem.

Britian Halts Oil Flow To Communist China

Reversing its earlier stand in the matter of shipping oil to Communist China, the British Government has instructed its marketing companies in the Far East to halt all sale of oil to that part of China held by the Reds.

The British foreign office formerly had refused a request that it follow the two American companies marketing in the Far East, Standard-Vacuum Oil Company, and the California-Texas Oil Company, Ltd., which halted petroleum shipments into Communist territory at the request of the State Department. The Shell organization had continued normal sales, while discontinuing sales of aviation gasoline.

With the Korean coast under blockade, the objective is to cut off the flow of petroleum to sources from which the Chinese Communists might obtain it and trans-ship it to their North Korean fellow Communists.

Receives Honorary Citation. D. W. McKay, right, recently received the annual citation from the Natural Gasoline Supply Men's Association of Tulsa, Oklahoma for his years of service to the natural gasoline industry. Better known as "Mac," McKay has been a field representative for The Cooper-Bessemer Corporation for many years. James E. Pew, president, NGA, center, makes the presentation as William Lowe, secretary of the association right, looks on.

NEWS

Steel Demand Increases

Russell B. Brown (IPAA counsel) has told the president that domestic producers will require at least 2,842,-200 tons of steel, at a yearly rate, to continue the current drilling averages of 140,000,000 ft and 40,000 wells annually. Oil country tubular goods will take 1,568,000 tons; line pipe, 407,-500 tons; and all other steel, such as bars, plates, and sheets, 866,700 tons.

Brown also stated that these figures do not include steel requirements for natural gasoline and pressure maintenance plants, which now supply about 470,000 bbl per day of petroleum liquids in addition to crude oil, nor do they cover steel needed for oil transportation, refining, and distribution. He warned that increased oil demands will require even more steel than the above estimated figures.

Plan Oil Show

A three day oil show over the Labor Day weekend, September 2, 3, and 4, is planned for the big midwest field of which Grayville, Illinois is the approximate center.

The event is being promoted under the name of the Tri-State Oil Show, and the slogan, "Oil speeds modern activities," and oil men from the three states of Illinois, Indiana, and Kentucky will participate. General chairman of the show is C. E. Curry, district superintendent for Sohio.

Back on MER Basis

All Texas oil fields except five in the Scurry County area are back on a "maximum efficient rating" producing basis this month. This basis was abandoned last March, after the war and post-war demands had been met.

Texas is producing 107,523 bbl more crude oil this month than last, bringing the quota to 2,580,328 bbl daily, almost 650,000 above last March. To meet MER East Texas fields will remain on a 19-day schedule averaging 277,520 bbl daily; other fields will be put on a 21-day basis with the exception of the Scurry County fields already mentioned.

Most operators at the Texas Railroad Commission's meeting this month agreed that the nation should increase its stock as a safety measure. Some operators expressed the belief, however, that increased demands due to the Korean war have not yet materialized.

Changes Company Name

The Husky Refining Company has been merged with the newly formed Husky Oil Company. This will give the company a name indicating its operations as those of a fully integrated oil company, according to Glenn E. Neilson, president. Company officials were unchanged, with two new directors being added.

The company's Canadian subsidiary, Husky Oil and Refining Ltd., is not affected by the merger.

Texaco's Mobile Petroleum Laboratory. Shown in the interior of the mobile lab are Dewey McDonald, Douglas Phillips, and Paul Howe of The Texas Company's Beacon, New York laboratories. Personnel of the two U. S. army reserve units at Beacon have just completed two weeks working in the laboratory, which is making a tour of army depots and oil companies from coast to coast.

Quaker State Acquires New Petroleum Properties

Acquisition by Quaker State Oil Refining Corporation of certain petroleum properties at Titusville, Pennsylvania from the Cities Service Oil Company (Pennsylvania) was jointly announced by the two companies.

H. E. Brandli, vice president and general manager of Cities Service Oil pointed out that the sale does not affect the company's marketing outlets in western Pennsylvania.

Sunray Purchases Gathering Systems

The purchase of two auxiliary crude oil pipe line gathering systems in south central Oklahoma has been announced by Sunray Oil Corporation's refining division.

Fifteen miles of 2-in. to 4-in. pipe lines in the Cruce, Northwest Cruce, Doyle, Southeast Doyle, West Doyle, and Gann pools of Stephens County, Oklahoma, have been purchased from the Interstate Oil Pipe Line Company. This new gathering system, currently handling some 800 bbl of high gravity sweet crude daily, has been connected into Sunray's present crude pipe line system east of Duncan, Oklahoma, where the company's high octane gasoline catalytic cracking refinery is located.

The second new Sunray line purchased from the Service Pipe Line Company consists of approximately 30 miles of 2-in. to 6-in. pipe for the delivery of some 600 bbl per day of crude oil through the company's system serving its Allen, Oklahoma refinery. This gathering system is in Seminole and Hughes counties, serving the Allen, Hawkins, Sasakwa townsites, East Sasakwa and Wofford pools.

Chemical Economics Service

Stanford Research Institute is launching a new type of information service with its Chemical Economics Handbook, plans for which have been announced to business and industrial leaders.

Designed for the special interest of executives and others planning company economic policies, the Handbook service is encyclopedic and will cover the field of chemical economics broadly and many aspects in detail. The Institute's Department of Business and Industrial Economics will furnish subscribers data sheets containing graphs of special chemical economic relationships covering consumption and production data for a wide variety of chemical products.

Gas Industry Plans Expansion Program

The gas utility industry will spend about $3,140,000,000 in the construction of new and expanded facilities in the five-year period 1950-54, according to a survey completed by the Bureau of Statistics, American Gas Association. Approximately $2.75 billion of the $3.14 billion total will be spent by the natural gas industry, it is estimated, and $388 million by other branches of the industry.

Gross construction expenditures of $6.10 billion either have been made or are planned for the 10-year period, 1945-54. The enormity of this expansion program is indicated by the fact that the $6.10 billion, 10-year construction estimate actually exceeds the value of total gas utility plant of approximately $5 billion in 1945.

During the first five years of the post-war construction activity, 1944-1949, the gas utility industry spent $2.96 billion for new facilities, including the $143 million spent for the purchase of the Big Inch and the Little Big Inch lines. Beginning at a moderate rate this construction program continued to accelerate to reach an all-time high in 1949 when $959.2 million were spent for facilities.

Construction expenditures during 1950, according to AGA estimates, may run more than a billion dollars for the first time in history.

Increased Imports Hurt Producers, State IPAA

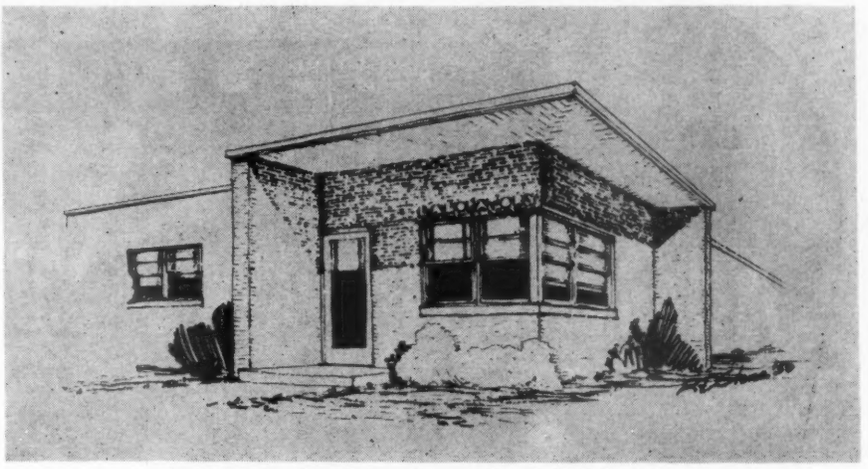
Increased imports of residual fuel oil since 1948 has influenced a 58 per cent drop in average daily income of domestic producers of heavy gravity crude oil in six typical U. S. fields, according to a report published by the Independent Petroleum Association of America.

The report, prepared by Minor S. Jameson, Jr., petroleum economist, shows that average production in 6 widely scattered heavy crude fields has been curtailed from 124,108 bbl daily in 1948 to 64,169 bbl a day in the first quarter of 1950. Areas included in the analysis are the Hawkins and Talco fields in Texas, Baxterville and East Heidelberg fields in Mississippi, Oregon Basin field, Wyoming, and Kern River field in California.

Publishes Booklet

The Petroleum Educational Institute, Los Angeles, California has published a booklet titled "When to Drain," based on the colored sound filmstrip of the same name. Copies of the fully illustrated booklet are available from the Institute at $1.50 per copy; for less in quantities.

Bureau of Mines Plans Radiochemical Laboratory



Architect's drawing of new B of M laboratory

With the completion this fall of a new radiochemical laboratory at the Bartlesville, Oklahoma, Petroleum Experiment Station of the Bureau of Mines, U. S. Department of the Interior, technologists at the station will be able to use radioisotopes in attacking many problems connected with the production and refining of petroleum, Secretary of the Interior Oscar L. Chapman has announced.

The laboratory, expected to be ready in September, is designed for the use of radioisotopes as tracers in various investigations in the secondary recovery of petroleum by water flooding and the injection of gas and air. The first application will be in using tracers, both radioactive and stable, in waters used for subsurface injection water-flooding. With the availability of tracers that can be introduced at input wells and detected at producing wells, data that have been unobtainable in the past will be provided.

Program Plans for Third World Petroleum Congress

The Third World Petroleum Congress will be held at The Hague-Scheveningen, Netherlands, from May 28 to June 6, 1951, according to advices received. The representative of the Society of Automotive Engineers, USA, is Earl Bartholomew, manager of Ethyl Corporation's Detroit, Michigan, research laboratories.

The Congress will present papers on, and discuss the following wide range of subjects: Geology, geophysics; drilling and production; physical operations in oil processing; oil processes involving chemical conversions; production of chemicals from petroleum; their properties and applications; measurement and control; analysis and testing; utilization of oil products; construction of equipment, materials, corrosion; transport, storage and distribution, and economics, statistics, documentation.

The Netherlands Organizing Committee is making strong efforts to obtain as many papers as possible from the USA; all papers and discussion will be published in the Proceedings of the Congress. Titles of papers to be written for the Congress should be sent either to Earl Bartholomew, member of the USA National Committee and SAE Representative, Ethyl Corporation, 1600 West Eight-Mile Road, Ferndale 20, Detroit, Michigan, or direct to Mr. Zwartsenberg, Secretary of the Third World Petroleum Congress, 30 Carel van Bylandtlaan Den Hague, Holland. Closing date for receipt of manuscripts has been set at September 1, 1950. Because of the shortness of time, authors are requested to obtain clearances from military authorities on any data disclosed which may affect the national security.

Wilson Address Published

The pertinent and highly informative address of Robert E. Wilson, chairman of the board of directors, Standard Oil Company (Indiana), which was given before the National Petroleum Association, has been published in booklet form by the NPA for distribution.

Under the title "Oil Competition in the Midwest" Wilson reviewed the history of the development of competition in the petroleum industry since the dissolution of the old Standard Oil Company in 1911. His address was an eye-opener to those inside and outside the oil industry who have had the idea that the oil business is monopolistic in character.

JUDGE IT BY THE

TIGER BRAND WIRE ROPE

PLENTY OF STRENGTH to lift the heaviest loads with this Tiger Brand 6 x 19, 1¼" line with wire core. This type of line has high resistance to crushing and gives extremely long service.

FASTER ROUND TRIPS are possible with smooth running Tiger Brand Preformed Lines strung with only 8 lines in the blocks instead of 12.

USS
AMERICAN
TIGER BRAND
WIRE ROPE
UNITED STATES STEEL

JOBS IT HANDLES

ON THE "LAGUNA MADRE"

—new off-shore drilling barge—

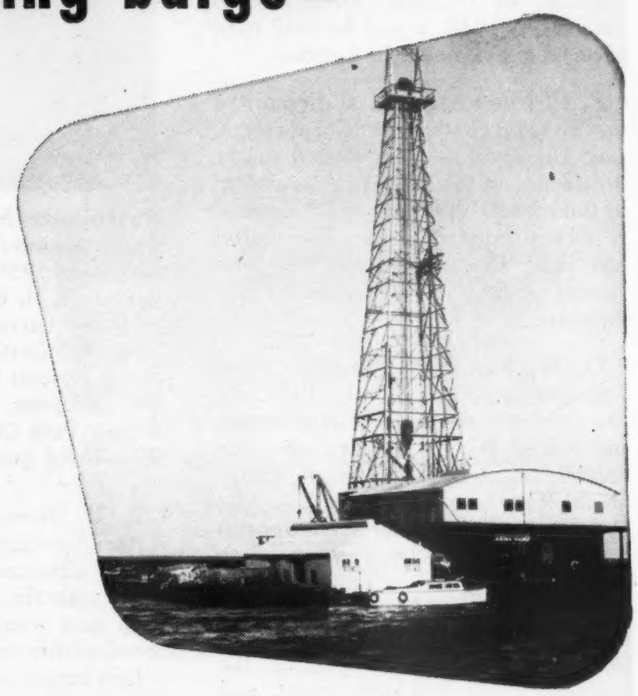
● The "Laguna Madre" is one of the most modern drilling barges in existence today. It was specially designed for the rugged service in the Gulf of Mexico. It is now drilling in the Black Bay area about 20 miles southeast of New Orleans.

Because of the long, slow trip out by boat, everything on the "Laguna Madre" was chosen for its ability to stand up in service. That's why they selected American Tiger Brand Preformed Wire Lines. From previous experience, the contractor knew that Tiger Brand stood at the top of the list for performance.

The Rotary Drilling Line is 2500 feet of 1¼" diameter 6 x 19 Monitor Improved Plow Steel with wire core. This has been in operation since January 14, 1950 and has given excellent service. They keep a careful check for signs of wear and cut off a section of line occasionally to distribute the wear. At the proper time, the line is reversed and the process repeated. Many thousand ton-miles of service are added by this kind of care.

Our booklet, "Valuable Facts about the Use and Care of Wire Rope," contains many other suggestions that will add appreciably to line life. Send the coupon for a copy.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



THE "LAGUNA MADRE" Drilling Barge, owned by Brewster-Bartle, Drilling Contractors. One of the finest rigs on the Gulf Coast—equipped with American Tiger Brand Wire Rope.

SEND FOR THESE BOOKLETS!

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☐ Valuable Facts about the Use and Care of Wire Rope
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Name.....

Position.....

Company.....

Address.....

USS

AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

UNITED STATES STEEL

Personals

Arnold Hofland, formerly general manager of Deutsche Shell A. G. has been appointed to take charge of European Area Management at the Shell head office at St. Helen's Court, London, in place of **F. A. C. Guepin,** who was recently appointed a director. In 1946 Hofland became oil advisor to the Allied Military Government in the British Zone of Occupation in Germany, at that time representing the interests of Shell in that country. He was appointed oil advisor to the Allied Military Government, and general manager of Deutsche Shell AG on January 1, 1948, a post he held until his new appointment in London.

E. P. Luongo, medical director of the General Petroleum Corporation, Los Angeles, has been elected to the presidency of the Western Association of Industrial Physicians and Surgeons. A vice president of the Association last year, Dr. Luongo has also previously served as a director of the organization.

D. W. Sims was recently named manager of Continental Oil Company's motor transportation division, succeeding **W. L. Kygar,** who was recently elected president of Continental Pipe Line Company.

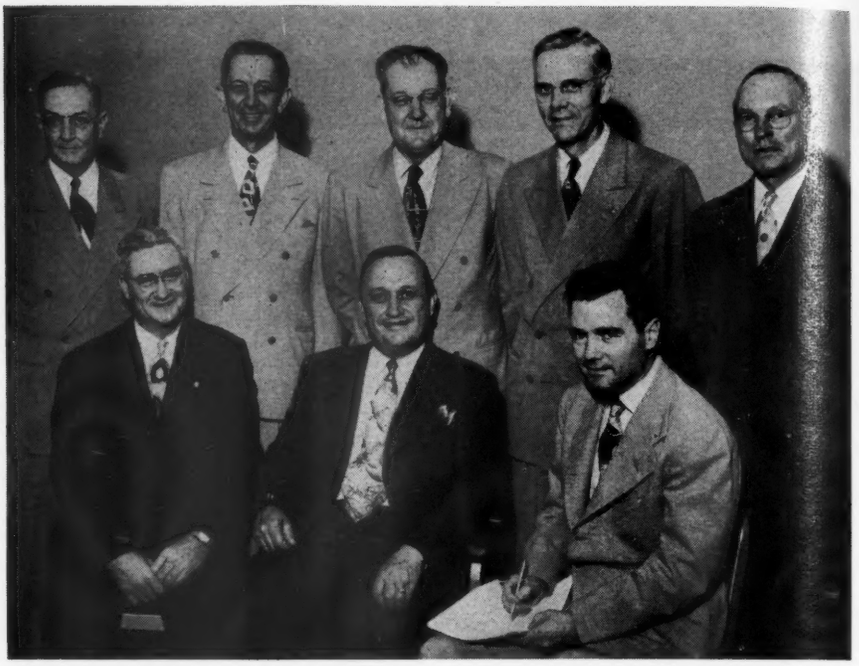
John Kelly, formerly transportation engineer, has been promoted to assistant manager.

Sims, who has been with Continental for more than 20 years, was formerly assistant manager of the company's pipe line department, and prior to that was superintendent of Continental's telephone and telegraph division. He is a graduate of Oklahoma A. & M. College.

Kelly has been Continental since 1946, serving in the company's production department at Hobbs, New Mexico, and Big Spring, Texas, 1949. A graduate of the University of Pittsburgh, he joined the motor transportation division in 1949.

Rear Admiral Thomas J. Kelly, U. S. Navy (Retired), has joined the Socony-Vacuum Oil Company, Inc., as an assistant to the chairman of the board. Admiral Kelly retired from the Navy after 33 years' service, which included two wars and considerable active combat duty.

During the Okinawa and Japanese campaigns, he commanded the Cruiser "Springfield" and was twice decorated for valor. He recently completed four years' duty in the office of the Chief of Naval Operations and has served on Joint Staff Committees.



Petroleum Motor Transport Association of Oklahoma Officials. Recently elected officials of the Petroleum Motor Transport Association of Oklahome for 1950-51 are: Seated, R. C. Hopper, Skelly Oil Company, first vice president; H. E. Thompson, Stanolind Oil and Gas Company, president; Ken H. Miller, Service Pipe Line Company, secretary-treasurer. Standing, C. E. Jackson, Mid-Continent Petroleum Corporation, director; H. J. Chambers, Oklahoma Natural Gas Company, director; J. W. Rayborn, Tide Water Associated Oil Company, director; W. H. Esser, Shell Oil Company, director; Harvey L. Bryant, Pure Oil, director. The association is composed of representatives from 29 oil and gas producing companies whose vehicles they supervise.

L. D. Jurs, vice president, Tide Water Associated Oil Company, has retired after completing more than 39 years with the company. He will remain as a member of the company's board of directors.

Jurs began work with Tide Water Associated as a draftsman in the engineering department in March, 1911. In 1912, he was appointed chief engineer, and it was during this period that many important projects were carried on in the company's expansion program.

Jurs was elected a vice president of Associated Oil Company in 1927, and December, 1936, was elected a vice president and a member of the board of directors of Tide Water Associated Oil Company.

C. Girard Davidson, assistant secretary of the Department of Interior, has been appointed head of all the Department's oil activities. These will include the Oil and Gas Division, the Division of Geography, the Bureau of Mines, and The Geological Survey.

Davidson is chiefly known as a member of the extreme liberal wing of the Administration. Several years ago he recommended that the government construct and operate steel plants, if necessary, to force an expansion of the industry. He recently sponsored an attempt to revise the Federal leasing regulations so that competitive bidding would be required for all leases on the same geological structure after the initial discovery of oil. The proposal was dropped by the Department.

Prentice F. Brown, Honolulu Oil Corporation, formerly in immediate charge of the company's operations in Texas, has resigned as vice president and director of the company. He has been associated with Honolulu Oil for 23 years.

P. M. McLaughlin, a member of the Arkansas Oil and Gas Commission staff, was recently appointed acting director of Conservation. **Lester A. Danforth,** director of conservation for the past 4 years, has resigned to enter private business in Tulsa, Oklahoma.

Ihsan R. Berent has resigned after six years with the Institute of Mineral Research, Ankara, Turkey. His resignation was accepted by the government.

L. L. Jupe was recently named manager of personnel and industrial relations for the Montreal division, Shell and Oil Company of Canada, Ltd. He is succeeded as manager of the departments in the company's Montreal refinery by **H. P. Dufresne.**

GREAT NEW ADVANTAGES IN TRUCK MIXERS

achieved with Chrysler Industrial Engines and Chrysler gýrol Fluid Drive

Reverse rotation of the drum without throwing damaging shocks and impacts into the transmission, engine and other parts of the machine!

No shear pins to replace! Smoother operation! Lower maintenance costs! Longer life! These are only a few of the advantages Chrysler Industrial Engines with gýrol Fluid Drive have brought to operation of truck mixers.

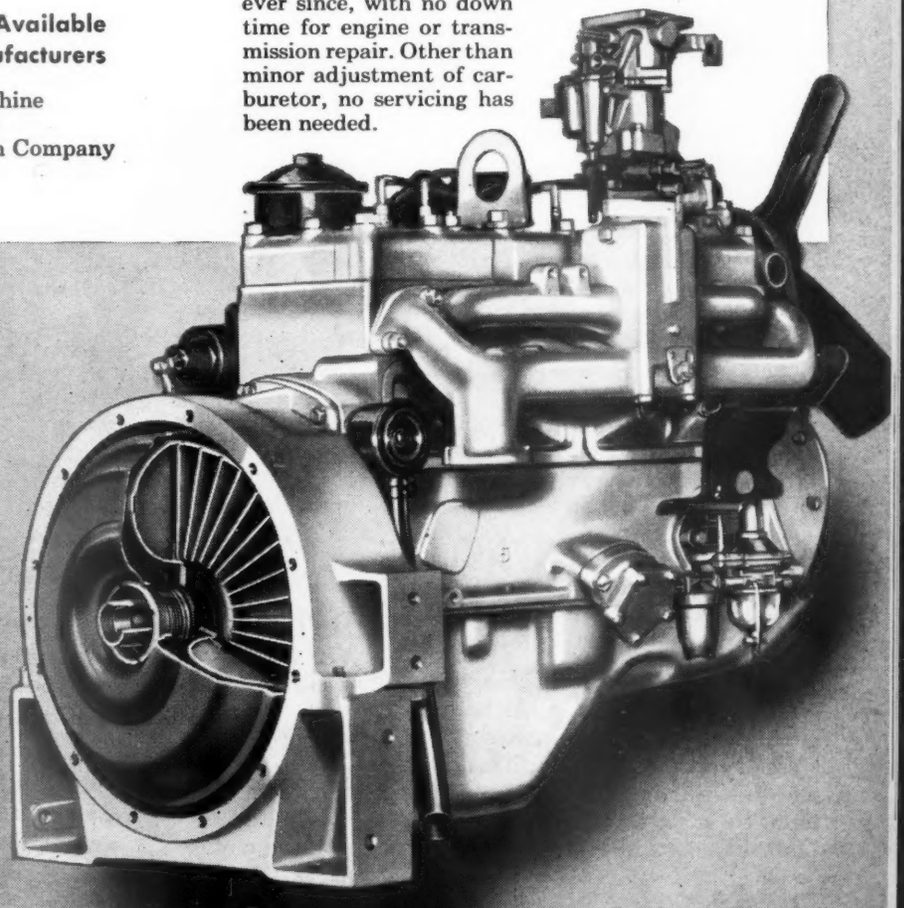
In addition, Chrysler Fluid Coupling prevents engine stalling, reduces clutch wear, eliminates jolts and gear rattle, simplifies starting from standstill with excessive load, gives gradual oil-smooth acceleration—opens a whole new field of improved operation for gasoline-powered equipment. See your Chrysler Industrial Engine Dealer or write us. ***Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.***

Chrysler gýrol Fluid Drive Now Available For Truck Mixers From These Manufacturers

Blaw-Knox Division of Blaw-Knox Company
Chain Belt Company
Jaeger Machine Company
T. L. Smith Company

A Typical Experience

Five years ago, a Rex Moto-Mixer equipped with Chrysler Industrial Engine and gýrol Fluid Drive was placed in operation by the Tews Lime and Cement Company of Milwaukee. The unit has been operated continuously ever since, with no down time for engine or transmission repair. Other than minor adjustment of carburetor, no servicing has been needed.

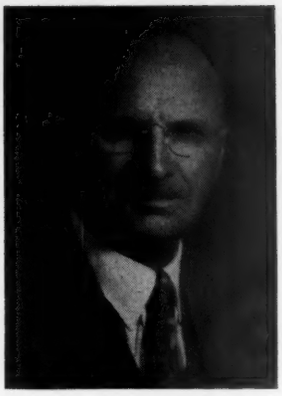


Chrysler gýrol Fluid Drive is built integral with Chrysler Industrial Engines. Its cost is only a few dollars more than the conventional flywheel which it replaces.

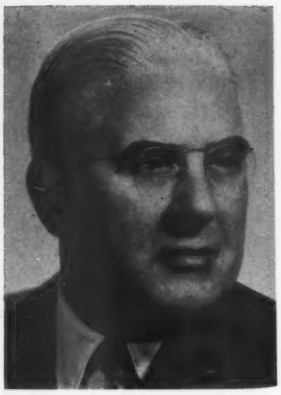
CHRYSLER
Industrial Engines and Power Units

HORSEPOWER WITH A PEDIGREE

R. S. Tulin



G. C. McLaren



Frank H. Hughes

R. S. Tulin, manager of the natural gas and gasoline department, Shell Oil Company has been elected president of the California Natural Gasoline Association at the annual meeting of the board of directors held in Los Angeles recently.

George C. McLaren, general superintendent of southern district natural gasoline department, Standard Oil Company of California, was elected to serve as vice president. **R. E. Millett, Jr.,** was reappointed as secretary-treasurer.

In addition to the past president, who are ex-officio members, the following were appointed to serve on the executive committee: Representing Class A members, **F. E. Bradley,** C.C.M.O. Company; **C. L. Case,** Continental Oil; **R. C. Enderly,** Wilmington Gasoline; **W. H. Kraft,** Honolulu Oil; **H. M. Paulsen,** The Norwalk Company; **E. W. Walker,** Western Gulf Oil. Class B memberships, **P. E. Foote,** Petrolane, Ltd.; **Wm. Moeller, Jr.,** Southern California Gas Company. Class C represented by **J. S. Fluor, Jr.,** The Fluor Corporation, Ltd.

Darrell H. Hamric has been elected a vice president of Republic National Bank. He will be associated with the petroleum department, and returns to Republic after several months absence on business.

A graduate of the University of Pennsylvania's Wharton School of Finance and Commerce, he did graduate work at the Wall Street Division of New York University. In 1931, Hamric became associated with the Bank of Manhattan Company in New York. He joined Bankers Trust in 1945, and one year later became connected with Republic.

H. M. "Don" Morse has been reappointed executive supervisor and secretary of the Mississippi State Oil and Gas Board for another year's term. He is a member of the Compact Commission engineering committee.

Frank H. Hughes has been appointed director of purchases of American Natural Gas Service Company. He will be stationed in the company's offices in the Penobscot Building, Detroit, Michigan.

Hughes has been in public utility purchasing for the past 24 years, serving at various times as director of purchases of the North American Light and Power Company, Northern Natural Gas Company, Illinois Power Company, and United Light and Railways Service Company.

American Natural Gas Service Company furnishes engineering, accounting and other technical services to its affiliates, Michigan Consolidated Gas Company, Michigan Wisconsin Pipe Line Company, Milwaukee Gas Light Company, and the parent company, American Natural Gas Company.

J. H. Pollard, who for some 25 years has been closely associated with major sulfur companies in construction, engineering, exploration, and general advisory capacities, announces the opening of his own office in Houston, Texas as a consultant in this field. Pollard is a graduate of the University of Texas. He has done both field and production work for Texas Gulf Sulphur Company, experimental and construction work for Freeport Sulphur Company, and was mine engineer and assistant mine manager for Duval Texas Sulphur Company.

He received the Legion of Merit from the U. S. Army for his war services, and was awarded by the Kingdom of Italy its highest knightly honor for the rehabilitation of the Sicilian sulfur mines.

Dr. Charles F. Weinaug has been promoted from associate professor of petroleum engineering to professor at the University of Kansas. A graduate of the University of Michigan, he worked for Phillips Petroleum Corporation for five years, before joining Kansas University in 1948.

E. L. Anders, Jr. was promoted from assistant professor of petroleum engineering to associate professor. Anders has an MS degree in petroleum engineering from the Colorado School of Mines. He joined the Kansas University staff in 1948, upon his resignation from Creole Petroleum Corporation in Venezuela.

Thirty Years Service. President O. C. Schorp of The Carter Oil Company is shown, above, receiving a pin denoting 30 years service from John W. Brice, New York, director of Standard Oil Company (New Jersey). John R. Suman, Jersey vice president and director looks on. Presentation was made in Tulsa, Oklahoma. A native of San Antonio, Texas, Schorp has been with Jersey Standard and affiliates since 1920 and for the past 7 years has been president of Carter. Much of his former work was done in Mexico and Venezuela with affiliates of the company.

LAUGH WITH BARNEY

Woman resident in China to her houseboy: "You should knock before bringing my linen into the bedroom."

Houseboy: "That's all right, missey. Every time I come, lookee through keyhole. Nothing on, no come in."

Two boys who were returning on the street car from Sunday school a few days after Christmas were discussing the lesson of the morning: "Do you believe all that stuff about the devil?" one asked.

"Naw," replied the other boy. "It's just like Santa Claus; it's your old man."

The best way to stop worrying about your competition is to make your competition worry about you.

Rosenbaum called up a Scandinavian concern and said, "Rosenbaum here, Hooz spikkin pliz?" Swede on the other end said, "I'm Yensen, the Secretary." Rosenbaum fumbled a bit, then exclaimed, "Oh, vell, I'l call back ven you're not so bizzy!"

Vellejo Father: I'll teach you to make love to my daughter!

Sailor: I sure wish you would. I haven't got much time on a six-hour pass.

"Is it a modern farm house?"

"No. Five rooms and a path."

A gent was being let out of an asylum as cured, and was saying farewell to the staff. "And what are you going to do, outside?" asked one doctor.

"Well," says the ex-nut, "in the past I was a lawyer—I might do that again. Or, I might go into the movies, or on the stage."

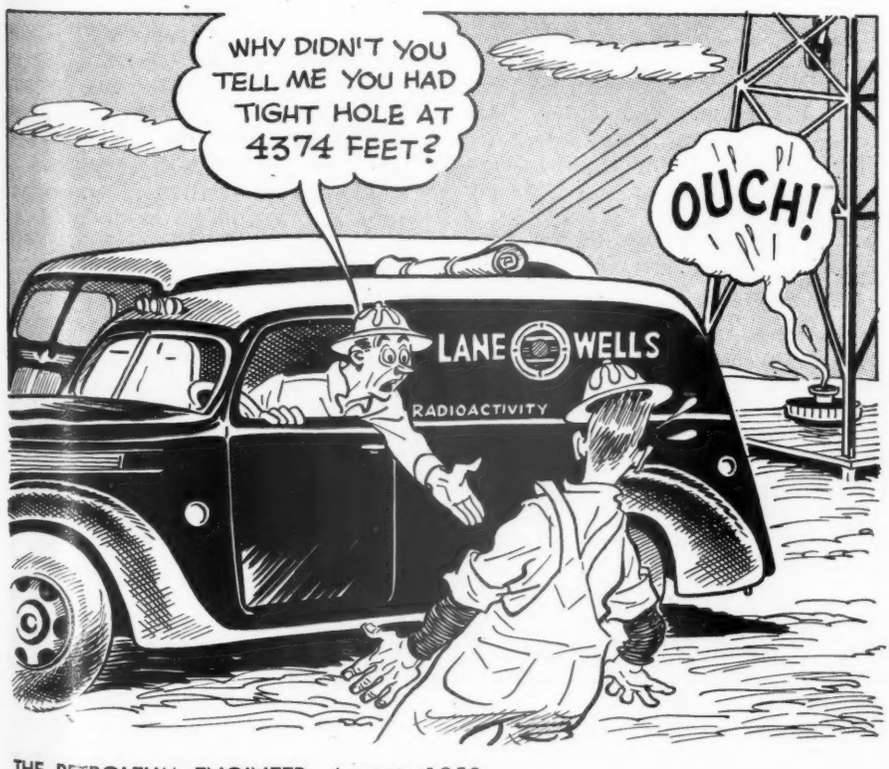
For a moment he seemed lost in thought. "On the other hand," he added, "I might be a fireless cooker."

Two elderly gentlemen were recalling the bitter disappointments they had experienced in life. Finally one of them commented: "I guess the worst disappointment I ever had occurred when I was a small boy. I had sneaked under a tent expecting to see a circus, and when I got in I found it was a revival meeting."

It had been a hard night for the young man. A convertible, the moon, and Mt. Bonnell had failed to help him, but just as it turned eleven o'clock he succeeded in getting a good-night kiss from his date.

"That's your reward for being a gentleman," the girl cooed.

"Reward?" he snorted. "That's just workman's compensation!"



When she found her first gray hair she thought she had nothing to live for—so she dyed.

"Let's stick this guy for the drinks," said one mosquito to the other.

With tears in her eyes, his wife exclaimed, "I know you don't love me; you've forgotten my birthday!"

"Darling," replied the quick thinker, "I am more sorry than I can say, but it is really your fault."

"My fault," she exclaimed. "How can it be my fault?"

He took her hand in his. "How can I remember your birthday." he asked, "when there is never anything about you to remind me that you are a day older than you were a year ago?"

College boys like suits with stripes in them, ties with dots in them, and letters with checks in them.

A lovely little old maiden lady contributed a pair of pajamas to the Red Cross during the War. "I made them myself," she said proudly. They were perfect in every detail, except for the fact that there was no opening in the front of the pants. When the inspector explained the error, the old lady's face fell. Suddenly she brightened. "Couldn't you give them to a bachelor?" she suggested.

The doctor's new secretary, a conscientious girl, was puzzled by an entry in the doctor's notes on an emergency case: "Shot in the lumbar region," it read. After a moment she brightened and, in the interest of clarity, typed in the record: "Shot in the woods."

Hay is something we must make between the time we get out of it and the time we hit it.

Number one item on the menu in a New Orleans restaurant the other day was
"Yankee Pot Roast—Southern Style"

News Item: LOCAL GIRL OVERCOME BY GAS WHILE TAKING BATH—

Miss Mary Jones owes her life to the watchfulness of the janitor and the elevator boy of the hotel where she was staying.

A hillbilly built a house for his bride in which he fashioned windows but no doors. "Where are the doors?" asked the nervous bride.

He drew up to his full height and replied, "Doors? You going some place?"

OIL AND GAS TRADE NEWS

Buda Plant Completed

The new 17,080 sq ft plant of the Buda Engine and Equipment Company of Dallas, Texas, is one of the largest buildings in the Trinity Industrial District, according to H. F. Moroney, treasurer.

Situated at 1601 Dragon, the building is faced with white face brick with a Roman brick facade. It has year-round air conditioning. The recessed entrance has a large glass door assembly. The property also includes an additional 3000 sq ft of concrete storage area.

Buda Engine and Equipment Company's new 17,080 sq ft plant.

Acme Company Observes 50th Anniversary

Acme Fishing Tool Company, Parkersburg, West Virginia, celebrates its 50th anniversary this year. The company, founded by George L. McKain, began as a small shop consisting of forging hammer, lathe, shaper, drill press, and accessories in the center of McKain's drilling operations in Pennsylvania, West Virginia, and Ohio in 1896.

Three years later, McKain gave up his contracting business and devoted his full time to his shop and fishing. Moving his shop to Salem, West Virginia, in 1900, McKain began manufacturing fishing tools exclusively. Three years after that, the one-man controlled business was moved to Parkersburg and incorporated as a West Virginia corporation.

Shown below are the late George L. McKain, founder; Lewis M. Ludlow, president and general manager, who succeeded the founder; Karl L. Elliott, treasurer and general sales manager, with Acme 30 years; Walter P. McKain, son of the founder, chief engineer; Merle G. Decker, sales engineer; Bayard Sweeney, field representative, A. D. McTaggart, boss tool maker.

Installs Mobile Telephone

Lufkin Foundry and Machine Company, Los Angeles, California, has installed a short wave mobile telephone unit in its service engineer's car. Bob Spaulding, who will be in contact with his office at all times, will be able to increase service coverage with the aid of the mobile telephone.

"We feel," Vic Fawcett, Lufkin's Los Angeles representative explained. "that in this way much travel time and back-tracking will be avoided."

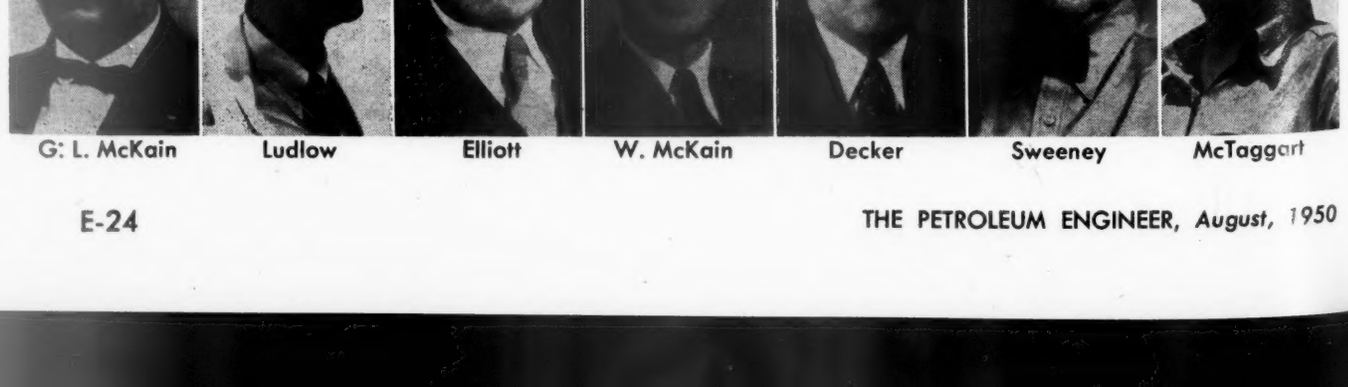
Names Two Representatives

J. T. Wing and Company of Windsor, Ontario, Canada, and Thomas Robertson and Company, Ltd., of Montreal have been appointed distributors of Tube-Turn welding fittings and flanges. These companies will represent both Tube Turns, Inc., and Tube Turns of Canada Limited.

Form Canadian Subsidiary

Builders Iron Foundry Industries of Canada, Limited, a subsidiary of Builders Iron Foundry, Providence, Rhode Island, was formed early in June for the manufacture of certain products made by Builders-Providence, Inc., and Omega Machine Company. In particular, BIF Industries of Canada, Limited, will produce Venturi meters, flow controllers and gages, Chlorinizer chlorine gas feeders, and Omega gravimetric and volumetric chemical feeders.

Officers of the new company include E. H. Bradley, president; G. W. Kelsey, vice president; E. D. Wilkes, vice president and general manager; H. S. Chafee, treasurer; W. H. Adam, secretary and assistant treasurer; B. C. Greenough, assistant secretary and treasurer; Kenneth MacMillan, assistant manager, and Ross Dunn, counsel.



G. L. McKain | Ludlow | Elliott | W. McKain | Decker | Sweeney | McTaggart

Establishes New Division

Nichols Engineering and Research Corporation announces the establishment of its Nerco-Niro spray dryer division. This newly established spray dryer division will coordinate its experiences, engineering, and research with those of A/S Niro Atomizer, Copenhagen, Denmark, who have engineered and installed over 200 industrial spray drying plants in 23 foreign countries for the production of a wide range of organic and inorganic products. The first installation in USA is now under construction for a plant in New Jersey.

Except for the atomizers, which are the heart of the Nerco-Niro spray dryers, all parts are manufactured in the USA. The atomizers will continue to be manufactured in the precision workshops of Copenhagen.

Bulletins and technical reports are available in several languages.

Celebrates 70th Year

Fisher Governor Company recently held a three-day international sales meeting at its home office and factory in Marshalltown, Iowa. One hundred twenty-five representatives, sales engineers, and their wives from the Fisher offices throughout the United States, Canada, and Mexico were in attendance as guests of the company. Fisher Governor celebrates its 70th anniversary this year.

Opens Detroit Branch

The opening of a new factory branch and warehouse at 2832 East Grand Boulevard, Detroit, Michigan, has been announced by the Cleco division of the Reed Roller Bit Company.

The Cleco division, manufacturers of air tools, air line couplings, valves, chisels, and other accessories, further announces the appointment of Jim Reed and Roger Winship as factory representatives for the Detroit area, with headquarters at the new address.

To Build Extrusion Plant

A new $1,000,000 extrusion plant for the fabrication of tubes of ferrous metals and alloys in complex sectional shapes, will be built in Beaver Falls, Pennsylvania, according to an announcement made by The Babcock and Wilcox Tube Company. The announcement followed the completion of a licensing agreement between the B&W Tube Company and Comptoir Industriel d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights.

Isaac Harter, chairman of the American company, explained that the new plant would be built at the site of the company's present facilities.

BENCH YOKE VISE

that's a real Time Saver

. . ."I don't have to worry about protecting polished pipe in these RIDGID LonGrip Vise jaws."

LonGrip Jaws Protect Polished Pipe in RIDGID Vises

● You get years of trouble-free service with this more-for-your-money RIDGID Bench Yoke Vise. You like its easier-work features—integral pipe rest, handy bender that won't flatten pipe and LonGrip jaws that protect polished pipe. Special malleable frame and heat-treated tool-steel jaws for maximum wear. Made in 8 sizes, for pipe to 6." RIDGID bench, post, stand and Tristand pipe vises, yoke and chain types, all offer you real work-saver advantages. Buy them at your Supply House.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL CO. • ELYRIA, OHIO

Dozier Graham Eastman Celebrates Its 25th Year in Business. In honor of its 25th anniversary, Dozier Graham Eastman gave a party for over 300 clients, media representatives, suppliers, and friends in Los Angeles recently. Above is Tom Boyd, Baash-Ross Tool Company, left, with Tom Bell, The Texas Company, and H. Woytkns, Baash-Ross. In the next photo are George Dieter and Harold Bordelon, Fluor Corporation, with Ed Dewey, account executive, DGE.

Establish New Divisions

Establishment of separate advertising and market development divisions in the general sales department of American Steel and Wire Company have been announced by Wilmer H. Cordes, general staff manager of that department. Appointed as manager of the advertising division was O. B. Stauffer, and as manager of the market development division was John E. McGrath. Both appointments are effective immediately.

Stauffer, a native of St. Paul, Minn., is a graduate of Baldwin-Wallace College. He has been associated with the American Steel and Wire Company since 1944. McGrath attended Ohio University. He has been associated with the company since July 1946.

Rector Moves Offices

The Rector Well Equipment Company, Inc., Fort Worth, Texas, has occupied its modern, new one story office building at NE 10th and Commerce Streets, across the street from company plant that was enlarged last year. The air conditioned steel and concrete building, which has 4000 sq ft of floor space, is designed for a second story that will be added in the future.

Armco Changes Offices

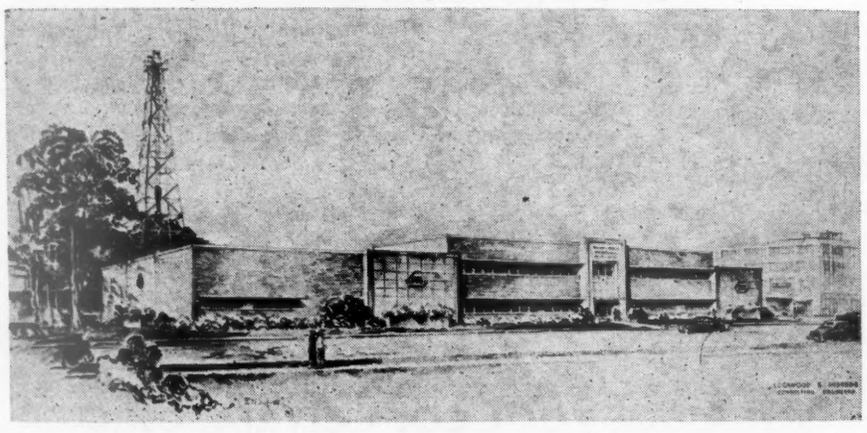
Announcement of a change of address is made by Armco Drainage and Metal Products, Inc., from its former location in the Mayo Building, Tulsa, to the Kome Building, 8th and Main Streets, Tulsa, Oklahoma. R. E. Walker is the district manager and Robert O. Hayes, salesman. Home office is situated at Middletown, Ohio.

Hughes Tool Plans 2 Million Dollar Lab

Plans have been completed for the erection of the new $2,000,000 Hughes Tool Company Engineering Laboratories in Houston, Texas. The building, covering 75,000 sq ft of floor space, will have in the 2-story center structure, in addition to a basement, the metallographic laboratory and offices on the first floor. The second will house the chemical laboratory, emission spectrum laboratory, projection room, and library.

The new laboratory building is scheduled to be completed by June, 1951. In addition to the present equipment, which will be moved to the new building upon its completion, a half a million dollars will be expended for new laboratory machines, technical apparatus, and equipment.

Proposed new laboratory to be built by Hughes.



Opens West Texas Branch

International Cementers, Inc., has opened a new operation in West Texas with headquarters at Odessa, according to a recent announcement by

R. D. Fagan Jerry Ormand

Bob Harcus, general manager. R. D. (Bob) Fagan has been named division manager with Jerry Ormand, originally from Longview, as his assistant.

Beside oil well cementing the company will offer Perfo-Jet (Jet casing perforating) and Strata-Jet (Jet formation penetrating) in West Texas fields. Permanent buildings now being erected at Odessa include a 30 by 60 ft office building, a 50 by 108 ft garage and shop, and a twin-silo bulk plant for handling cement and lightweight aggregate.

Holds Annual Sales Meet

Sperry-Sun Well Surveying Company held its annual sales conference in the general oil country headquarters, 3118 Blodgett Avenue, Houston, recently. Sales and service engineers from division points throughout the nation reviewed new and improved developments, made plans for the coming year and heard safety talks.

During the week of the conference headed by S. H. Williston, vice president from Philadelphia, and A. B. Palmer, general manager, Houston, a company barbecue was held for employees and their families.

Plan 4 New Furnaces

The Youngstown Sheet and Tube Company plans to build 4 new open hearth furnaces and other facilities at its Indiana Harbor plant at East Chicago, Indiana. The new furnaces, with necessary facilities, will produce 550,000 to 600,000 tons of ingots per year.

After these furnaces are in operation, the Bessemer department at Indiana Harbor will be discontinued. A new roll shop will be erected at the Indiana Harbor strip mill and finishing facilities will be added for hot rolled sheets and strip.

Organizes New Field Set-Up

A new field organization arrangement to facilitate "on the spot" sales, engineering, and repair service for well servicing and drilling units has been inaugurated by Franks Manufacturing Corporation of Tulsa, according to Art Knight, sales manager.

District managers have been appointed for seven areas as follows:

K. M. Lamer, (1) with headquarters at Odessa, to serve West Texas and New Mexico; Albert Hastings (2), Kilgore, to serve East Texas, Northern Louisiana, and Arkansas; E. R. Rudy (3), Alice, to serve Southwest Texas; Vern Alley (4), Houston, to serve Houston, Gulf Coast, and Southern Louisiana; R. E. Knobloch (5), Great Bend, to serve Kansas; A. J. Rogers (6), Casper, to serve the Rocky Mountain area, and T. H. Alexander (7), Mt. Vernon, to serve the Illinois basin. Oklahoma will be served from the Tulsa headquarters and factory.

California will be served by the Franks branch plant at Compton, under the sales direction of R. M. White (8), and the service direction of George Lewis (9).

Show A. O. Smith Movie

An 18-minute sales and institutional sound motion picture in full color is being shown by the A. O. Smith Corporation at dealer meetings over the country. The film, titled "1500 Water Heaters a Day, The Modern Electric Way," pictures the background of A. O. Smith production of capital goods, development of glass-surfaced steel leading to the firm's entry into the water heater field, and finally the many uses to which Americans now put hot water in the home.

Obtains Gas Lift Equipment

Wilson Supply Company, Houston, Texas, through its president, Wallace D. Wilson, announces it has acquired the distribution of the Bryan gas lift equipment. This equipment will now be known as Wilson-Bryan gas lift equipment and augments the "Nixon Surface Control Gas-Lift System," manufactured and distributed by Wilson Supply Company for many years.

Moves Sales Office

The San Francisco sales office of the Chicago Bridge and Iron Company was moved from 22 Battery Street to Room 617, 200 Bush Street recently.

L. A. Elsener is manager of the San Francisco office, assisted by K. W. Lange, contracting engineer.

Gar Wood Acquires New Subsidiary

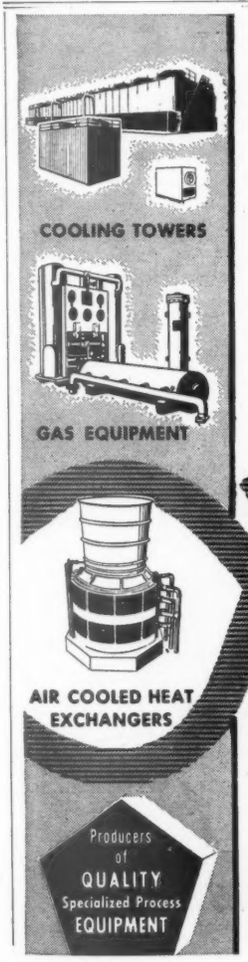
E. F. Fisher, president of Gar Wood Industries, Inc., announced recently the purchase by his company of the National Truck Equipment Company, Waukesha, Wisconsin. This property will be owned and operated by a newly formed and wholly owned subsidiary of Gar Wood, to be known as the National Lift Company.

Through its new subsidiary Gar Wood Industries now makes available cost-saving equipment especially designed for trucks one ton and under. To the regular Gar Wood lines, products added by the National Lift Company are the Dump-O-Matic twin hydraulic hoist for ½, ¾, and one ton trucks, and the Hydra-Clutch pump.

Beaver Pipe Tools Celebrates 50th Year

Beaver Pipe Tools, Inc., Warren, Ohio, celebrated its 50th anniversary in June. Organized in Warren in 1900, it is still housed in the building in which the first Packard automobile was constructed by the Packard Brothers, then of Warren.

Beaver offers a complete line of tools for cutting and threading pipe from ⅛ to 12 in. Its employees hold service records of 10 to 45 years.



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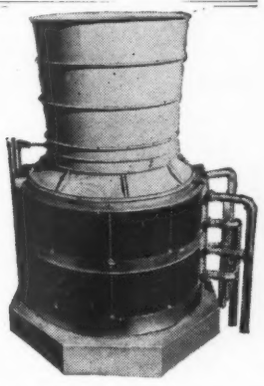

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Attend Training School

Safety directors, fire marshals, and maintenance experts of oil, utility, railroad, and industrial companies in the midwestern area attended the Gustin - Bacon Manufacturing Company's annual fire training school held recently in Kansas City, Missouri.

C. H. Armstrong, manager of industrial sales for Gustin-Bacon, in announcing the courses, explained that the purpose of the school is to acquaint the trainees with the operation and maintenance of Ansul dry chemical fire extinguishers.

Forms English Company

Jerguson Gage and Valve Company of Somerville, Massachusetts, has formed an English company in collaboration with the Tress Engineering Company. The English company, Jerguson Tress Gage and Valve Company, Ltd., has headquarters at Africa House, London, and uses the manufacturing facilities of Tress Engineering Company.

Officers and directors of Jerguson Tress Gage and Valve are Cecil W. B. Tress, chairman; E. Sheard, chief engineer, and W. Birks Creasser, sales manager, with headquarters at London, and Brooks Stevens, Jr., E. E. van Ham, N. Garfield, and James A. Ford, with headquarters at Somerville.

Stentz Gets New Offices

The Stenz Equipment Company recently moved its headquarters office at Tulsa, Oklahoma, from 226 East Fourth Street, to 5605 East Admiral Place.

New headquarters include both offices and show rooms in the front of the building, and an extensive warehouse in the rear. This expansion permits the Stentz Equipment Company to maintain all of their warehouse stock as well as manufacturing, in a central location, which was not possible at the old headquarters.

Kileen Company Is Agent

The appointment of the T. F. Killeen Company, 374 Delaware Avenue, Buffalo 2, New York, as its Western New York State representative, has been announced by the Hammond Iron Works, Warren and Bristol, Pennsylvania. Hammond, for the past half-century has been designer, fabricators, and erector of steel storage tanks of cone roof, breather, sphere, spheroid, floating roof, and vapor-lift design, etc.

Changes Company Name

National Technical Laboratories has announced that it has changed its corporate name to "Beckman Instruments, Inc." This action was taken for the purpose of associating the corporate name more closely with the trademark of its principal products.

In the early years of National Technical Laboratories the manufacture of Beckman instruments was only one of several activities in which the company was engaged. In recent years Beckman instruments have become the major interest of the company.

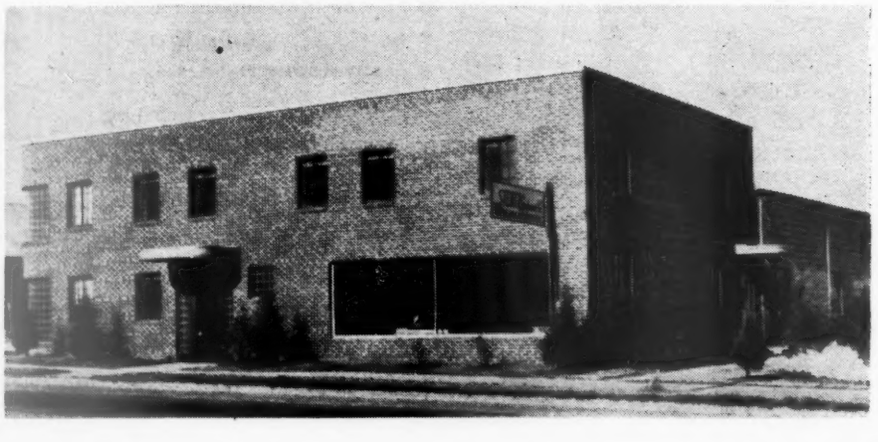
Morton Bearing Buys New Britain Company

Morton Bearing Company, Ann Arbor, Michigan, has purchased the machinery and assets of the New Britain Bearing Company, Inc. The new address is 200 Hill Street in Ann Arbor.

Hudson T. Morton is president of the new company. He has had 25 years experience in engineering, metallurgy, manufacturing, testing, and servicing of anti-friction bearings, 21 years with Hoover Ball and Bearing Company, and four years with The Fafnir Bearing Company.

The policy of supplying replacement thrust ball bearings and thrust roller bearings and other makes of bearings will be continued. In addition production of standard sizes will be produced. Some cataloged bearings will be kept in stock.

Stentz Equipment Company's new Tulsa office.



STAINLESS STEEL

WHICH ALLOY FOR YOUR PIPING JOB?

Industry is rapidly turning to stainless steels as standard material for an increasing number of piping applications. Their ability to withstand the action of many corrosive agents, their toughness in sub-zero applications, their strength and ductility in elevated temperatures, and their high scaling-resistant properties, answer many tough piping problems.

Recent surveys show that 95% of the demand for stainless steel piping is in these three types:

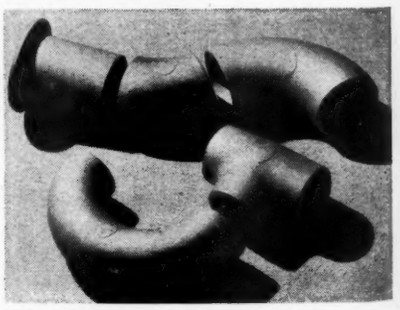
Type 304—18% chromium, 8% nickel
Type 347—18% chromium, 8% nickel, 1% Columbium
Type 316—18% chromium, 8% nickel, 2% Molybdenum

Each exhibits inherent qualities that make it ideal for certain applications. Thus, while the group as a whole covers 95% of industry's needs, individual applications should be studied carefully to determine which grade is best for the job.

For example, a prominent soap manufacturer's requirements are 10% Type 304, to eliminate product contamination—45% Type 347, to carry low temperature organic acids—and 45% Type 316, to carry the same acids at elevated temperatures.

In the food and dairy industry, where the service is only mildly corrosive, the main reason for using stainless steel is to promote cleanliness and to eliminate contamination. Type 304 satisfies most of the demand here.

To provide the greater strength, greater safety and permanently leakproof joints of welded piping construction, Tube Turns, Inc. has developed a wide selection of types and sizes of welded fittings and flanges in all three grades of stainless steels listed above. It's the most complete line available today.



TUBE-TURN Stainless Steel Welding Fittings made of the three alloy types listed here, are available in a wide range of parts and sizes, including elbows, returns, tees, reducers, caps, lap joint stub ends, laterals and crosses. Flanges are also furnished.

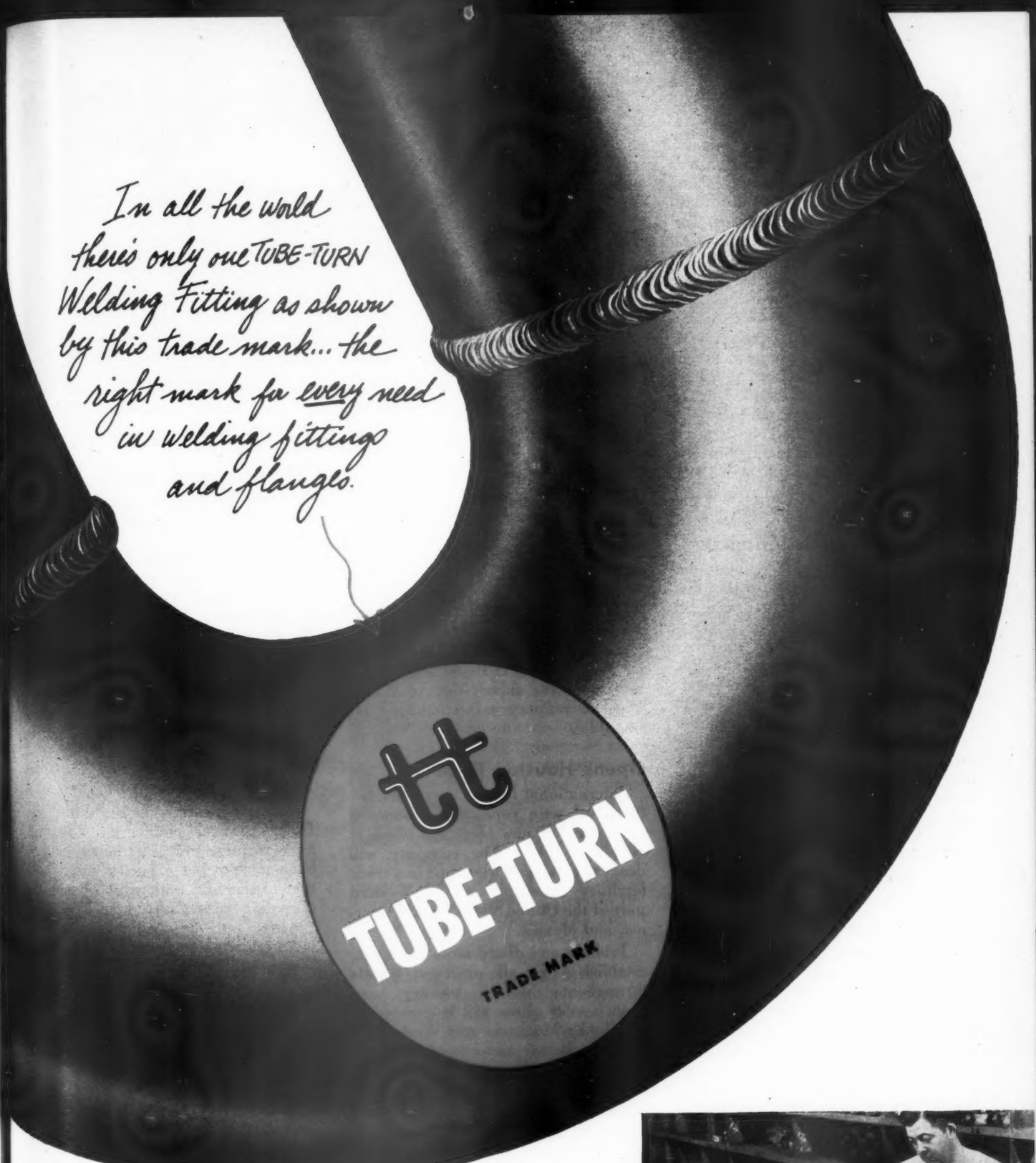
NEW CATALOG

Write today for your free copy of the new Stainless Steel catalog, just published by Tube Turns, Inc. It contains the complete description of TUBE-TURN Stainless Steel Welding Fittings and Flanges, as well as valuable information on the use of stainless steel piping.

"Be Sure You See The Double tt"

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY



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Gorman-Rupp Names Eastern Distributor

The Charles W. M. Coote Company, Inc., was recently named as eastern representative to serve the petroleum industry by The Gorman-Rupp Company, Mansfield, Ohio. Sale of Gorman-Rupp products to the major oil companies of the New York Metropolitan area will be handled by the Brand-Welch Sales Company of New York City.

Coote, head of the Charles W. M. Coote Company, has a long record of service in the petroleum industry, having begun his work in 1933 in the laboratories of Standard Oil Company of New Jersey. In 1948, he entered the pump field culminating in the establishment of his own firm in 1949, to distribute petroleum handling equipment.

Opens Service Departments

Mack Trucks, Inc., has inaugurated three new departments for the dissemination of factual information about trucking in the public interest. One department, trucking information service, will supply factual information to press, radio, and television editors on all phases of the trucking industry and Mack Trucks, Inc.

A second department, trucking service bureau, will assist the entire trucking industry "to better its relations with the public," E. D. Bransome, president of Mack Trucks, stated. The third department inaugurated by Mack Trucks is called better living through increased highway transportation.

Appoint Distributors

Ampco Metal, Inc., Milwaukee, Wisconsin, have announced that the Jaeger Welding Supply, Inc., Springfield, Massachusetts, and the Texas Welding Supply Company of Dallas, Texas, have been appointed as franchised distributors in their respective areas. Each will handle the complete line of various grades of electrodes.

General Electric's apparatus department's 10-car exhibit streamliner. The train is filled with exhibits of more than 2000 of the Company's latest products.

Republic Supply Expands

Republic Supply Company has recently opened a new store at Harvey, Louisiana and a sales office at New Orleans. The Harvey store is managed by J. P. Smith, II, who is assisted by M. T. Maloney and W. B. Pattillo. The New Orleans office is situated in the International Trade Mart Building, and is under the direction of Jack Halbert. Both sales points are under the supervision of W. M. Haynes, refinery sales manager for Republic.

Opens Houston Plant

International Ropes, Inc., manufacturers of wire rope, has announced opening of its new plant and offices at Houston, Texas. The company will deal exclusively in wire rope in a trade territory consisting of the Western part of the United States, South America, and Mexico.

Jobbers and distributors are being established in all principal points throughout the oil country, and branch sales offices will be opened in the Rocky Mountain and West Coast districts, it was announced by E. E. Lambert, president.

Plant manager of the new company is James A. Halbert.

Houston plant and offices for International Ropes.

IDECO Opens Supply Store

T. D. "Hi" Collins, vice president, IDECO supply stores division, recently annouced the opening of a new IDECO supply store at Graham, Texas. Robert C. Webb has been appointed the Graham store manager. N. C. Thompson, formerly associated with the Bethlehem Supply Company, has been appointed assistant store manager. B. L. Morris has been assigned to Graham as field sales representative. The store will be operated under the direction of A. L. Oliver, district manager.

Builds Hypersorption Unit

Foster Wheeler will build for the Dow Chemical Company its second hypersorption unit. The new unit will have a charging capacity five times that of the first unit, which has been operating successfully since 1947.

Three pure product streams, viz., C-1's and lighter from the top, C-2's as the middle cut and C-3's and heavier as the bottom fraction will be separated from the cracking plant effluent.

Five New Agents Named

Robert S. Hudgins, Jr., will cover North and South Carolina as a representative for Chiksan Company, Brea, California. The Southern Corporation, Charleston, South Carolina, will continue to represent Chiksan in the pulp and paper industry in these states.

R. S. Stover Company, Kresge Building, Marshalltown, Iowa, has been appointed to cover the states of Iowa and Nebraska; the Geo. S. Thomson Company, Inc., Phoenix, Arizona will cover the state of Arizona; the Jos W. Eshelman & Company, Inc., Birmingham, Alabama will cover Alabama and parts of Tennessee and Florida, and Rittelmeyer and Company, Inc., Atlanta 1, Georgia will cover the entire state of Georgia and a part of Florida.

TRADE PERSONALS

Grover Seaberg, formerly in business for himself, has joined Middle West Coating and Supply as West Coast representative. Seaberg began his career over 30 years ago as a chemist for the People's Gas Light and Coke Company of Chicago, Illinois. His next job was field engineer for the Dresser Coupling Company of Bradford, Pennsylvania, contacting major oil, gas, and water companies from coast to coast.

Joseph E. Holveck, hydraulic engineer, Worthington Pump and Machinery Corporation, died recently in Montclair, New Jersey. From 1901 to 1935 Holveck was connected with Aldrich Pump Company at Allentown and Pittsburgh, Pennsylvania, eventually becoming a vice president of that company. He joined Worthington in 1935 as a sales engineer.

Robert J. Cannon, eldest son of the late James H. Cannon, founder of the Cannon Electric Development Company, has been appointed president and treasurer. Since 1933 he has been active in this business, and has served as vice president and general manager since 1942.

Other officers just elected, are **Richard L. Rowen,** vice president and production manager, and **John B. Milliken,** secretary.

Landis O. Morris, Jr., has been assigned to the staff of Robert S. Tyler, Jr., manager of the Tulsa office of Tube Turns, Inc. He was born in Louisville, Kentucky, and attended Centre College. He joined Tube Turns, Inc., in July 1949.

C. J. Woodard, Pelton Water Wheel Company, formerly in charge of sales and service of the long stroke hydraulic pumping jack division, has been made manager of the oil industry machinery division. Headquarters of this division are at 2447 East 54th Street, Los Angeles.

C. J. Woodard

Woodard joined Pelton Water Wheel Company as an engineer in the hydraulic turbine and valve division. He was later assigned to the development and marketing of long stroke hydraulic pumping equipment.

J. K. Sutter has been appointed Pittsburgh district manager for the Spang-Chalfant division of The National Supply Company. He has been Boston sales representative for Spang-Chalfant since 1944. A native of Pittsburgh, Sutter joined Spang-Chalfant's sales department in 1927 and later worked in the New York and Memphis sales offices.

He succeeds **C. J. Ramsburg, Jr.,** who has been promoted to the position of manager of welded product sales for Spang-Chalfant.

Charles L. Haslup, was recently appointed sales manager of the R-P&C valve division of American Chain and Cable Company, Inc. His headquarters will be at Reading, Pennsylvania.

J. H. Lollar, Jr., has been named president of Republic Supply Company, Houston, Texas. **H. B. Catlow** will become vice president in charge of sales. Both men will continue to serve on the board of directors.

J. H. Lollar, Jr.

Republic Supply, now celebrating its 40th anniversary, operates 47 service points in 9 states from its headquarters in the National Standard Building in Houston.

J. "Doug" Charters, Turco Products, Inc., district sales manager of the company's Houston, Texas, division, has been transferred to the Northern California sales district, with headquarters in San Francisco. He assumes this post to fill the vacancy which occurred owing to the death of Al Martinez, district manager. **"Chris" Williams,** who has been assistant district manager in Houston for the past 6 years, moves into the spot left vacant by Charters' transfer.

L. A. Dixon, Jr., has been named assistant vice president of Rockwell Manufacturing Company's meter and valve division. He will assist in the coordination of sales and factory problems and make his headquarters at the company's home office in Pittsburgh. For the past two years he has been the general manager of the Pittsburgh-DuBois division of Rockwell.

David W. Barnett

David W. Barnett has been named sales geologist for Lane-Wells Canadian Company at Calgary, Alberta.

Barnett was a geologist for Kennco Explorations of Canada where he worked in Northern British Columbia and did exploration work with the Eldorado Mining and Refining Company in the Lake Athabasca region.

Neil Jones has been appointed sales manager of United Supply and Manufacturing Company, Tulsa, Oklahoma. Jones began his career in the oil country at the age of 16, and his first job was on a drilling rig near Cushing, Oklahoma. In 1937 he became superintendent of Clark Pipe Line Company.

He has been associated in sales work for United Supply since 1941, in Odessa and Tulsa.

M. E. (Monty) Montrose, vice president, sales, has been appointed to the board of directors of Hughes Tool Company. Others appointed to the board of directors are **Thomas A. Slack,** vice president, general counsel, and **Daniel J. Martin,** vice president, engineering.

Fred W. Ayers, senior vice president and general manager stated that addition of these top executives to the board brings closer coordination of the many commercial and engineering projects of this company.

W. H. Siems, former export manager of the New York office of Hughes Tool Company, has been appointed assistant general sales manager of the company.

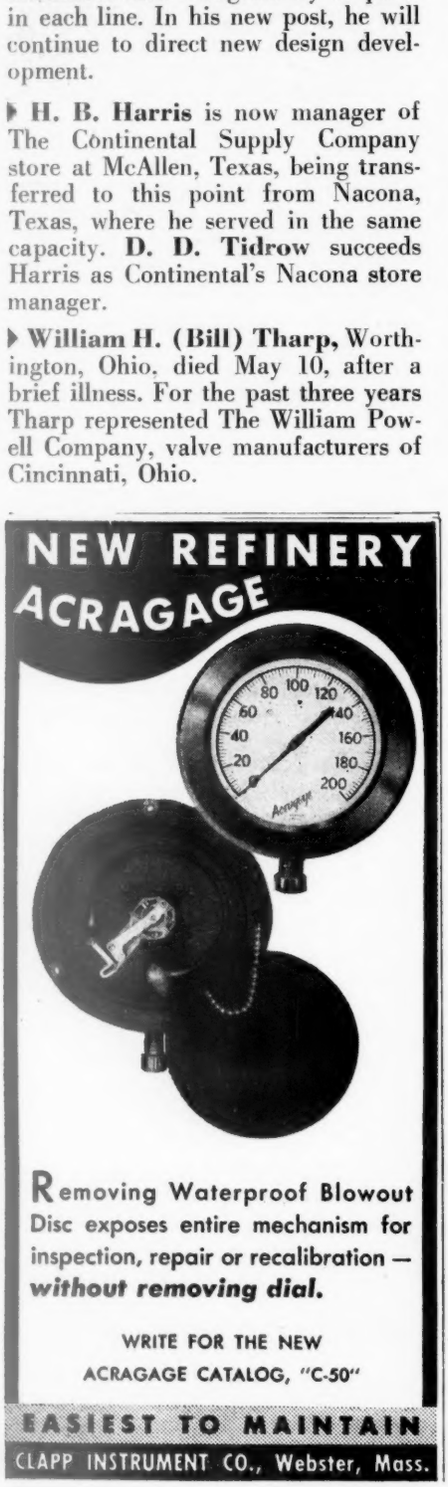
Siems joined the company in 1929 and has made his headquarters in New York for the past 20 years. In Houston he will assist in the general supervision and coordination of the company's field sales and service activities, both domestic and foreign.

▸ **V. Lobanoff** has been appointed chief engineer for United Centrifugal Pumps, division of United Iron Works. During recent years, Lobanoff has been credited with major responsibility for development of a number of new United Centrifugal Pump designs, and a program to affect maximum interchangeability of parts in each line. In his new post, he will continue to direct new design development.

V. Lobanoff

▸ **H. B. Harris** is now manager of The Continental Supply Company store at McAllen, Texas, being transferred to this point from Nacona, Texas, where he served in the same capacity. **D. D. Tidrow** succeeds Harris as Continental's Nacona store manager.

▸ **William H. (Bill) Tharp,** Worthington, Ohio, died May 10, after a brief illness. For the past three years Tharp represented The William Powell Company, valve manufacturers of Cincinnati, Ohio.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ACRAGAGE
Removing Waterproof Blowout Disc exposes entire mechanism for inspection, repair or recalibration — *without removing dial.*
WRITE FOR THE NEW ACRAGAGE CATALOG, "C-50"
EASIEST TO MAINTAIN
CLAPP INSTRUMENT CO., Webster, Mass.

▸ **A. F. Boucher** has assumed sales and engineering responsibilities as district manager in the Detroit, Michigan, area for the Lincoln Electric Company of Cleveland, Ohio. He has been transferred to Detroit from Milwaukee, Wisconsin where, since 1947, he has been district manager. Boucher joined the Lincoln staff in 1936 after his graduation from the Ohio State University.

I. R. Bartter has been transferred from Grand Rapids to Milwaukee to assume the responsibilities of district manager in that area for the Lincoln Electric. Bartter has been district manager for Lincoln in Grand Rapids since 1945. He joined Lincoln in 1936.

▸ **W. Ray Kern** has been appointed sales manager of Winslow Engineering Company, manufacturers of Winslow filters and elements. He assumed his new duties on May 15 after resigning as vice president and general manager of Berglund Tractor and Equipment Company, after 15 years with the company.

Kern's long experience in the field of heavy machinery and affiliated industries dates back to positions that he held in prior years with Enterprise Engine and Foundry Company and Frisco Standard.

▸ **Carl E. Schmitz,** vice president and director of engineering, Crane Packing Company, Chicago, Illinois, was elected vice president at large of the American Society of Lubrication Engineers at the annual convention just concluded in Detroit, Michigan. He was previously treasurer and regional vice president.

His other current activities include chairmanship of a sub-committee on engine design for the Society of Automotive Engineers and membership on the conference committee of the National Conference on Industrial Hydraulics.

▸ **W. A. Lutsch** has been named manager of Dearborn Chemical Company's branch office operations in Detroit and the state of Michigan.

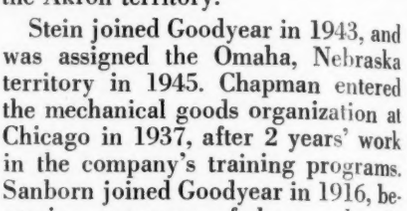
Lutsch has been with Dearborn since 1936. After two years in the Chicago office, he joined the Detroit sales staff in 1938. He will make his headquarters in Dearborn's Detroit office, 3240 Book Tower Building.

▸ **G. L. Phillippe** has been appointed department comptroller for the General Electric Company's apparatus department, succeeding the late **G. S. Hyatt.** Phillippe was graduated from the University of Nebraska in 1932 with a BS degree in business administration, and the following year received his master's degree there. He joined General Electric in 1933.

▸ **R. C. Stein** has been promoted to manager of molded goods sales at the St. Mary, Ohio plant for Goodyear Tire and Rubber Company. **R. E. Chapman** was appointed manager of hose sales, Akron, succeeding **R. W. Sanborn,** who is now representing the mechanical goods division in the Akron territory.

Stein joined Goodyear in 1943, and was assigned the Omaha, Nebraska territory in 1945. Chapman entered the mechanical goods organization at Chicago in 1937, after 2 years' work in the company's training programs. Sanborn joined Goodyear in 1916, becoming manager of hose sales in Akron in 1938.

▸ **Ralph L. Boyer** and **William E. Stevenson** have been elected to the board of directors of Cooper-Bessemer Corporation. Boyer is presently vice president and chief engineer of the


W. E. Stevenson R. L. Boyer

company, and Stevenson is president of Oberlin College, Oberlin, Ohio.

Boyer, a graduate from Ohio State University, joined Cooper-Bessemer in 1926 as diesel engineer, later becoming assistant chief engineer, then chief engineer, until his election to vice president and chief engineer in 1947.

A graduate of Princeton, Stevenson attended Oxford University in England where he received his MA degree. During the war he served as American Red Cross delegate to Great Britain, North Africa, and Italy. Prior to his becoming president of Oberlin College, he was a partner in the New York law firm of Debevoise, Stevenson, Plimpton and Page.

▸ **Harry J. Schneider** was recently appointed sales representative of Rockwell Manufacturing Company. He will assist **D. L. Jerman** in sales work for all gas products used in the gas industry in New Jersey; also regulator and valve lines of the Pittsburgh equitable meter and Nordstrom valve divisions of Rockwell.

Schneider attended the Stevens Institute of Technology and was previously employed in the Gas Engineering Department of Stone and Webster Service Corporation.

William H. Yeckley, formerly general superintendent of the Campbell Works steel plant, and **Dr. Karl L. Fetters,** formerly special metallurgical engineer, have been elected assistants to **A. S. Glossbrenner,** vice president in charge of operations, The Youngstown Sheet and Tube Company.

Yeckley joined Youngstown in 1937, from the Lorain plant of National Tube Company. He is a Princeton graduate. Fetters began work for Youngstown in 1936 as open hearth metallurgist. He was graduated from Carnegie Institute of Technology and the Massachusetts Institute of Technology.

Melvin W. Pauly has been appointed New York manager of Lunkenheimer Company, Cincinnati, Ohio. Pauly, associated with the valve industry for over a decade, assumed responsibility for Lunkenheimer's New York operation the first of June.

H. E. (Ike) Lowery, sales representative for The Continental Supply Company at the New Orleans, Louisiana, district office has been transferred to the district office in Houston as manager of drilling equipment sales for the Gulf Coast.

John J. Dean, until June 1 salesman for Continental at the Houston district office, has been transferred to Harvey, Louisiana, as store manager.

Robert J. Wigg has been appointed sales - service representative for The Wm. Powell Company, Cincinnati, Ohio. Wigg, whose headquarters are 317 Builders Exchange Building, Portland 4, Oregon, will call upon the trade in Oregon, Washington, and Idaho, heretofore covered by **Charles M. Keyser.**

Thurman J. Holladay has been transferred from United Supply and Manufacturing Company's store in Hobbs, New Mexico, to manage United's new store at Snyder, Texas. He has been associated with United Supply since 1942.

Thomas M. Camerden, district manager of sales, American Steel and Wire Company, has been named Pittsburgh, Pennsylvania, district manager of sales. He will be succeeded by **Paul L. Lindsay,** who has been identified with several U. S. Steel subsidiaries for 17 years in engineering and sales capacities.

Camerden is a veteran of 41 years service with American Steel and Wire. He began as an office boy in the company's New York sales office in 1909. Lindsay transferred to American Steel and Wire Company from Carnegie Steel Corporation in 1934.

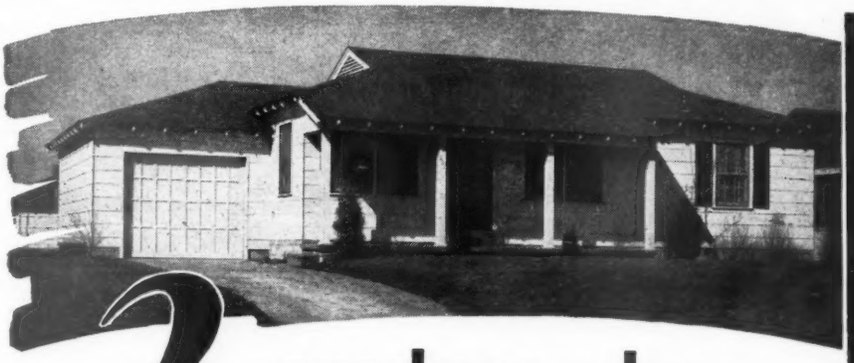
Fred G. Berling, advertising manager for the Lunkenheimer Company, Cincinnati, Ohio, retired recently under the company's retirement program, after 31 years of service. He joined Lunkenheimer in March, 1919, as a buyer and progressed through various assignments and departments to his appointment as advertising manager in April 1946.

With Berling's retirement the functions of the Lunkenheimer advertising department will be consolidated with the sales department, and some are being transferred to the company's advertising agency, Norman Malone and Associates of Akron, Ohio.

Lester N. Selig, chairman of the board of General American Transportation Corporation, Chicago, Illinois, has been elected chairman of the board of the General American-Evans Company.

Ben Colman, vice president of Evans Products Company, Plymouth, Michigan, has been elected president of General American-Evans Company with general offices in Detroit, Michigan.

V. R. Weiss, formerly of O. C. Duryea Corporation and a director of The Hulson Company, has been elected executive vice president of General American-Evans Company.



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Now, you can get Whitmor distinctive Field Homes on two separate plans . . . We will build them for you according to your plans and specifications—or ours . . . or we will build them and rent them to you on a new lease plan designed to fit your requirements. It's another great service to make Whitmor Homes available to an even greater number of companies. When you compare these distinctive homes with others in the field, you will see what we mean when we say that they are superior in every way. Our 29 years experience in building quality houses in every price bracket makes it possible for us to offer you custom built field homes at no extra cost. Let us give you more details about these two purchase plans . . . Write for our new illustrated folder.

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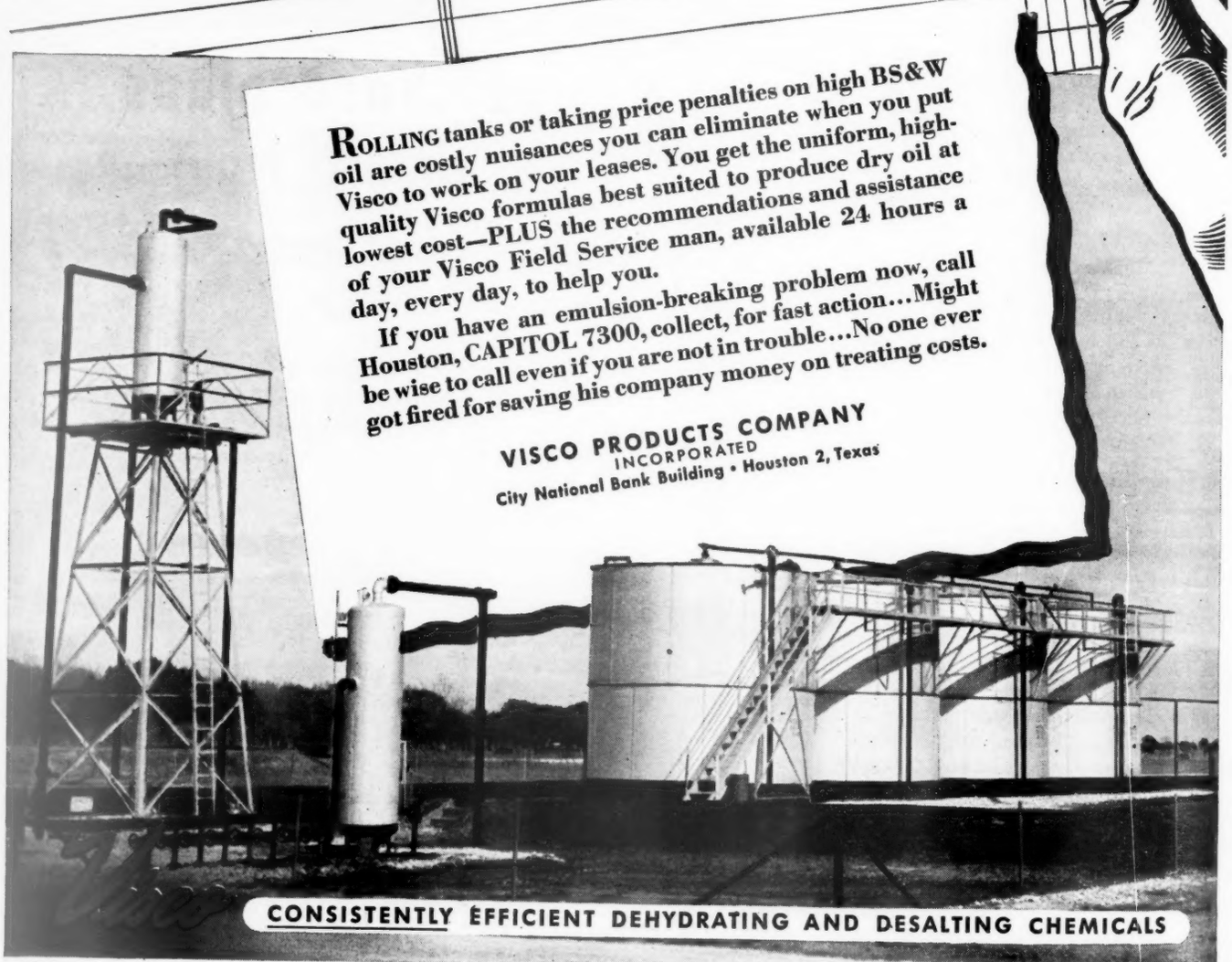
A BARREL OF BLUE

TO STOP LOSSES LIKE THIS

Rolling tanks



ROLLING tanks or taking price penalties on high BS&W oil are costly nuisances you can eliminate when you put Visco to work on your leases. You get the uniform, high-quality Visco formulas best suited to produce dry oil at lowest cost—PLUS the recommendations and assistance of your Visco Field Service man, available 24 hours a day, every day, to help you.

If you have an emulsion-breaking problem now, call Houston, CAPITOL 7300, collect, for fast action...Might be wise to call even if you are not in trouble...No one ever got fired for saving his company money on treating costs.

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INCORPORATED
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CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating compounds for use in the breaking and resolving of oil emulsions, and to grant licenses for such use, under the following United States patents: 1,860,562; 1,860,563; 1,912,330; 1,937,259; 2,050,639; 2,050,640; 2,206,589; 2,214,783; 2,214,784; 2,225,189; 2,303,414; 2,307,813; 2,318,034; 2,318,035; 2,321,056; 2,335,554. Re. 20,717 and patents pending. Any purchaser of Visco Oil Treating compounds is authorized to use the same in the treating, breaking and resolving of oil emulsions in accordance with the above patents. The royalty for such use is included in the purchase price. Visco Products Company is authorized to and is willing to grant licenses on a royalty basis, to all companies, and to others desiring to practice the patented subject matter, under any and all of the above patents, permitting the user to purchase the oil treating compounds at will from any vendor, and to prepare the compounds for use under the above patent or patents, at a royalty charge of 20 cents per gallon. Application for license should be made to Visco Products Company, Houston, Texas.

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

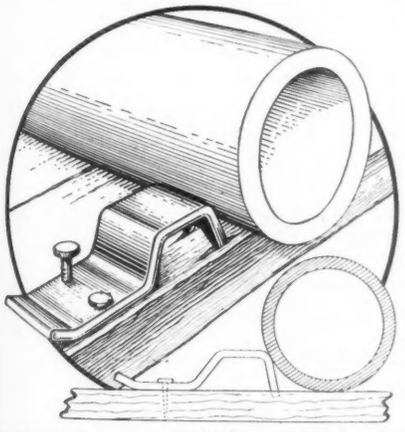
(1) Dairy Water Heater

Need for running water is eliminated in the new A. O. Smith Permaglas dairy water heater now in production at Kankakee, Illinois, the company claims. The 15-gal unit is filled through a pour pan in the top and delivers hot water from a brass spout at the side.

Heart of the Permaglas unit is a glass-surfaced steel tank with a thermostatically-controlled wrap-around heating element. The heater is portable, weighing 109 lb empty. Installation requires only plugging into an ordinary 110-v a-c electrical outlet.

(2) Pipe Stop

A new device for racking pipe is being manufactured and sold under the name of the Ledo Pipe Stop. This pipe stop is designed to be nailed to the wood runner under a layer of pipe, to hold the outside joints from rolling. It is designed so that the more pressure applied against it, the deeper the teeth sink into the wood runner and the stronger it becomes. A lip on the back side makes it easy to remove with a hammer or pinch bar. Of sturdy steel construction, it can be used over and over without bending or losing its effectiveness.



(3) Wire Rope Cutter

Announcement of a new "Model W" to its line of Hydrashear wire rope cutters has just been made by the Pell Cable Cutter Company of San Francisco, California. This new Hydrashear has been designed especially for use with cable-controlled equipment, for elevator repair work or wherever a small, portable, lightweight cutter is required.

The "Model W" Hydrashear weighs 18 lb, yet will cut any type and size of wire rope up to and including ¾ in. diam. It is only 12 in. long, 3½ in. wide and 6 in. high, yet is self-contained and requires no outside power or additional tools, claims the manufacturer.

(4) Air Cooling Equipment

The Happy Company has just announced its new line of air cooled, finned tube, radiator type cooling equipment. Some changes included in new design, according to the company, include larger fan diameter in some sizes, better support of fan and shaft, stronger construction, elimination of air leaks, etc.

Designs include both vertical and horizontal cooling sections, forced and induced draft. Special consideration has been given to proper sizing of units to give complete range of capacities by using multiples of basic units for flexibility or single large units where variable speed drive is available.

Get Full Details of August, 1950, Listing—Check and Mail Coupon to

THE PETROLEUM ENGINEER
P. O. Box 1589, Dallas, Texas

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		

NAME ..... TITLE .....

COMPANY NAME .....

STREET ADDRESS .....

CITY ..... ZONE NO. ..... STATE .....

To the
MANUFACTURER
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of
VAPOR
CONSERVATION
EQUIPMENT

For every vapor conservation unit requiring a flexible seal, VULCAN has the answer. Coated fabrics which will withstand gasoline of high aromatic content, and even high sulphur content crude, have been developed by VULCAN. These materials will withstand fumes and direct contact with the liquid.

When making or buying vapor conservation equipment, specify VULCAN coated fabrics for every type of seal. If yours is a special problem in conservation, VULCAN can offer technical help in the solution. Write for informative literature.

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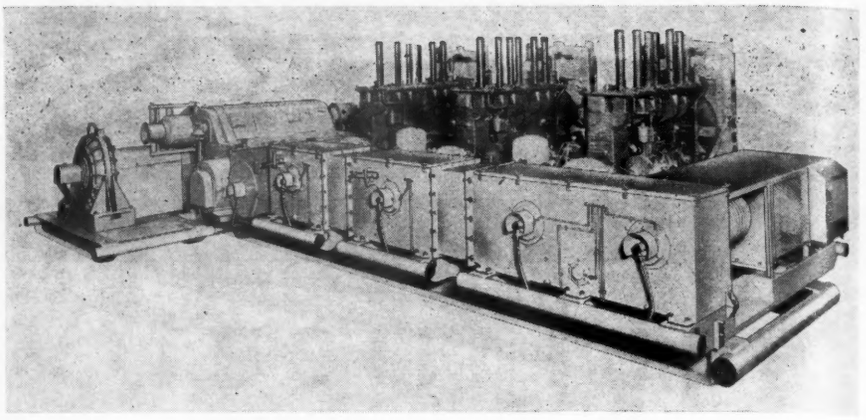

Wilson Manufacturing Company's new rig.

(5) Drilling Rig

Wilson Manufacturing Company has developed a new rig specifically designed to be used either with torque converters or direct engine drive. It can be purchased as a direct driven rig, without torque converters, and converters can be added at any time later, with no changes in rig or drive system. Or, it can be purchased with torque converters, and if desired torque converters can be removed and converted to direct engine drive.

The new Wilson Torcair is available with chain driven rotary table, universal shaft driven table, or with independent table drive unit. The latter unit is available either with or without cathead shaft. Engine radiators are conventionally mounted in front of engines, if the purchaser desires, or they may be mounted over engines with a bevel gear and V-belt drive to fans to blow air upward.

(6) Pipe Line Welding

A new light weight mobile engine-driven direct current arc welder especially designed for pipe line welding has just been released by Hobart Brothers Company, Troy, Ohio.

This new welder, known as "Pipeliner," is for use on pipe lines where light weight equipment is essential for easy handling and moving, but with a hot, fast arc and enough engine power to keep production up to or ahead of schedule. Its generator is rated 250 amp at 40 v on 60 per cent duty cycle and has a welding range of 30 to 325 amp.

(7) Underreamer

Grant Oil Tool Company, Los Angeles, has developed a new underreamer of the roller cutter type that, according to the company, performs with equal efficiency in hard and abrasive formations normally requiring rock bits and in soft strata. This tool has a positive expanding action and a cutting capacity that assures full gage hole. One feature of the new underreamer, states the manufacturer, is that it does not need to be taken out of the hole in order to reset the cutter assemblies, saving much hoisting time and energy.

(8) Aircraft Refueler

A 97-lb opposed twin-cylinder Onan Model CK engine provides the motive power for the Fuel-A-Plane, a self-propelled aircraft refueler manufactured by the Harman Equipment Company of Los Angeles.

The Fuel-A-Plane has the Onan CK engine mounted in the rear, covered by a latticed engine housing, and the driver's seat, which folds back for easy power plant accessibility. Forward and reverse gear transmission is of a marine type. Power is delivered to the rear driving wheels through Twin Disc fluid couplings. When loaded to capacity, the unit cruises at 10 miles per hour.

BUSINESS FOR SALE?

A nationally known and long established manufacturer in the capital goods field is interested in purchasing a small, going company that produces a capital goods type of product or products.

The product must have its major sales potential in the petroleum and chemical industries, be adaptable to present manufacturing facilities.

If for financial, management or marketing reasons, the owner or owners of such a company are contemplating its sale, please write Box 113, care of this publication.

All replies will be treated with the strictest confidence.

(9) Paint Coating

The Wilbur and Williams Company, Boston, Massachusetts, has developed a new enamel, which it claims is entirely odorless, thus enabling painting to be done in the presence of food with no danger of food tainting.

Supplied in white, the enamel dries dust free in three hours, it may be brushed or sprayed, and goes over damp or dry surfaces, painted or unpainted, the company claims. It is safe to use on fresh plaster walls with its undercoater. It is claimed to be resistant to gasoline, carbon-tetrachloride, and lime in plaster.

(10) Load Binder

Roll Boomer Manufacturing Company, Tulsa, Oklahoma, has designed a new load binder, which is marketed under the trade name Roll Boomer.

A cable chain winding over an oval shaped drum permits ⅓ more take-up and additional pulling power, according to the manufacturer. This extra take-up makes it unnecessary to take another bite in many cases and it is an important feature in binding loose material. As the chain is taken up, the pulling power increases until the handle is in closed position. Added flexibility allows the Boomer to conform to the load, eliminating all side strain on the swivels. The Roll Boomer releases the load gradually.

(11) Stem Valve

Granberg Corporation of Oakland, California, has announced a new stem valve, incorporating slow-closing, hydraulically balanced features that, it is claimed, eliminates valve slamming, line shock, and difficult opening due to line pressure.

The Granco valve has "finger-tip control." Closing speed is adjustable over a wide range by an adjustment screw on the outside of the valve. Adjustment can be made without draining lines or product spillage. Positive sealing action is accomplished by use of a thiokol valve face that can be easily reversed.

Granco loading stem valves are stocked in 2, 2½, 3, and 4 in. sizes with standard 125-lb flanges.

(12) Compound Dispenser

The technical equipment division of Turco Products, Inc., Los Angeles, California, have announced development of its new Handisan dispenser. Engineered with a baffle-plate at the top, the Handisan dispenser makes it impossible to force open the lid and wastefully scoop out handfuls of compound, the company claims.

Designed for use with Turco Handisan, white granular hand-washing compound, the dispenser can be refilled and maintained.

Use **DURA HOOKS**

***Sturdy* ALL STEEL**
Packing Pullers

HERE is a time saving device for removing old packing from stuffing boxes that will improve your man-power efficiency. DURA HOOKS are rugged, flexible hand-tools that can be used in "hard-to-get-at" places. For best results use two hooks as shown in illustration. Order your requirements to-day . . .

DURA HOOKS - HANDY SETS

Set No.	Description	Price
Set AA	Consists of 3 pairs of hooks, 7½", 11" & 15" in length. For use in packing spaces ¼" to ½" incl.	$ 10.00
Set BB	Consists of 4 pairs of hooks, 7½", 11", 15" & 19" in length. For use in packing spaces ¼" to ⅝" incl.	17.00
Set CC	Consists of 5 pairs of hooks, 7½", 11", 15", 19" & 22" in length. For use in packing spaces ¼" to 1" incl.	25.00
Set DD	Consists of 6 pairs of hooks, 7½", 11", 15", 19", 22" & 30" in length. For use in packing spaces ¼" to all over 1 inch.	37.00

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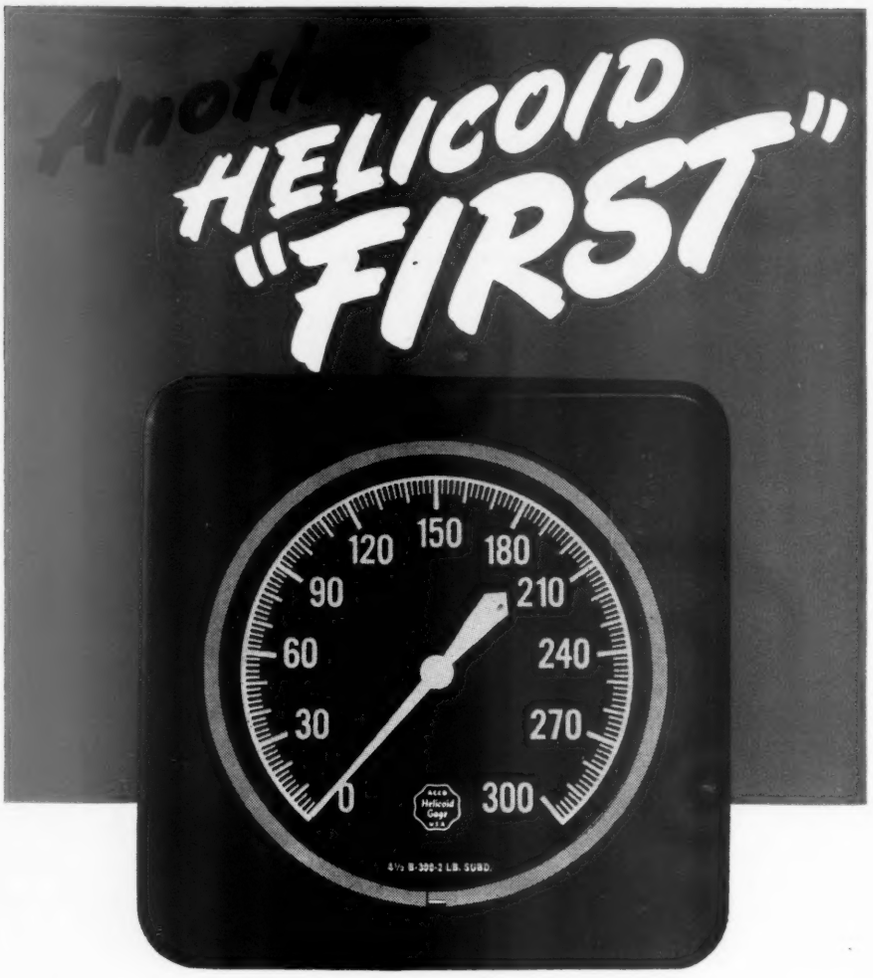
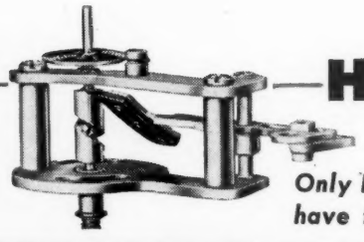
The PERFECT SEAL
KALAMAZOO MICHIGAN

MANUFACTURERS OF METALLIC AND SEMI-METALLIC PACKING
ROTARY MECHANICAL SEALS AND PACKING TOOLS



NEW SQUARE, FLUSH CASE GAGE

- ideal for symmetrical panels
- saves space, improves appearance
- 4½", 6" and 8½" dial sizes
- all standard pressure ranges
- with or without internal illumination
- insist on HELICOID GAGES in the new square flush case for that next panel job



HELICOID

ACCO

Only Helicoid Pressure Gages have the Helicoid Movement

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

(13) Snatch Block

A new snatch block has been developed by LeBus Rotary Tool Works, Inc., Longview, Texas.

A new lock pin design does away with any tool requirements. There are no threaded bolts or nuts. Within a matter of seconds, the wire line can be inserted in the sheave by turning the lock pin to the right, then pushing the pin through the slot thereby releasing the side plate; by reversing this procedure the block is ready for use. This procedure can be enacted when block is hanging in derrick or atop the gin pole without the use of tools, according to the manufacturer.

(14) Rubber Tire Machines

The availability of 2 new Lorain rubber tire machines, each rated at 25 tons lifting capacity on outriggers at 10 ft radius, and capable of working with 130 ft of boom, is announced by The Thew Shovel Company, Lorain, Ohio. These machines are known as models MC-504 and MC-504W and will be marketed under the trade name "Moto-Crane."

Both are new machines developed by modifying the recently announced Lorain-50 "Series" turntable and mounting it on newly designed, heavy-duty rubber tire carriers. The turntable of these machines are powered by 6-cylinder gasoline engines. Power is delivered through a Twin Disc hydraulic coupling power take-off and thence by a multiple strand roller chain drive to the operating mechanism.

(15) Reamer Stabilizer

Security Engineering Company, Inc., San Francisco, California, is manufacturing and announces the general availability of the Reamer-Stabilizer. According to Security, when this tool is run between drill collars, it eliminates drill string whip and vibration, thus increasing the over all rig drilling efficiency.

Security engineers state that more weight may be run on the bit without the usual undesirable effects of reduced directional control, drill string wobble, rock bit gyration, etc. Three angularly set barrel-shaped cutters contact the formation over their entire length. These cutters act as a large roller bearing contacting over one-third of the hole circumference, absorbing and transmitting to the formation all forces tending to start drill stem whip and rock bit gyration.

(16) Industrial Clothing

Chem-Wear Corporation states that industrial clothing made from Union Carbide's "Vinyon" N yarn have a high degree of resistance to destructive chemicals at concentrations widely used in the industry. Resistance of the new work clothing to chemicals is inherent in the fiber, the manufacturer states; the fabric is not treated. Although not fire-proof, Chem-Wear is fire-resistant and will not support combustion.

In extensive testing, the company reported further, Cheme-Wear clothing withstood more than 65 hr of continuous commercial laundering in the highest caustic soap concentrations used in launderies. This is roughly equivalent to more than 120 average washings.

(17) Chemical Pump

A gas driven rotary motor chemical pump has been added to the line of the McCord Corporation, Detroit, Michigan, Class "C" chemical pumps.

In this new pump, according to McCord spokesmen, there are no piston rings, rockers, counter weights, or reciprocating parts to wear. A rotor and four sliding valves are the only moving parts in the motor. This results in a compact and totally enclosed unit. Motor shaft is fitted with thrust bearings, and the entire unit is manufactured to close tolerances.

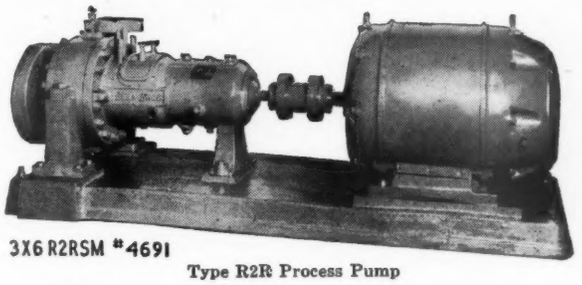
(18) Drilling Recorder

Warren Automatic Tool Company, Houston, Texas, has developed a new device for recording on a strip chart all drilling operations by relating them to the various positions of the traveling block. Known as a Rig Runner, there are no cranks, levers, or clutches for the driller to operate. A few notes and comments written directly on the chart will provide a comprehensive drilling report.

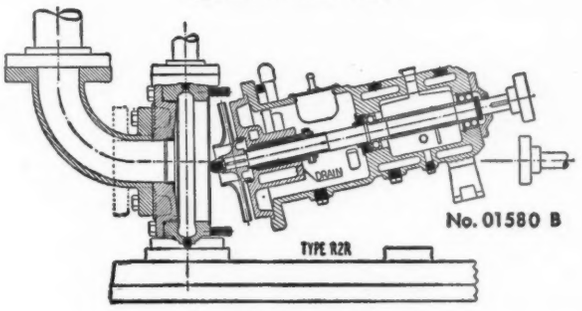
Each chart roll is sufficient for more than 2 weeks of continuous operation, but the chart may be torn off daily if desired, without losing the continuity of the record, reports the company. A low pitched warning notifies the driller of routine operations. A high pitched horn signals the entire crew when the block approaches dangerously close to the crown.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

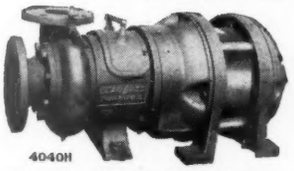
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

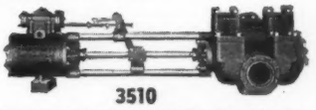
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

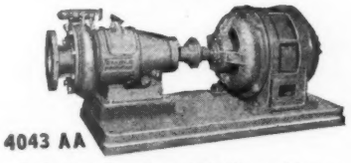


Close Coupled Centrifugal Pump

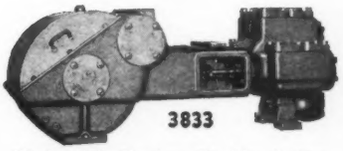


3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

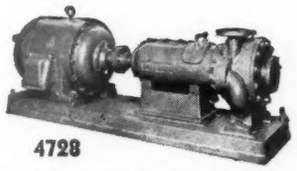


Pedestal Mounted Centrifugal Pump



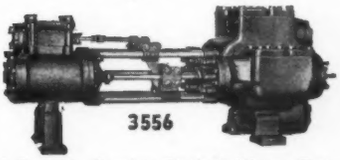
3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump



3556

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

(19) Steam Jets

The Series FM-1A Karbate Brand impervious graphite circulating steam jet is announced by National Carbon Division, Union Carbide and Carbon Corporation, New York City. The jet itself is made entirely of "Karbate" impervious graphite, while the riser is standard Karbate impervious graphite pipe fitted with a Neoprene Flexlock gasket at the submerged connection to the jet and a Type V flange connection at the other end, permitting simple connection to steam lines. They are available in two sizes, Size 2 and 4, with riser assemblies up to 9 ft-3¾ in. in height, and supplement the two types of Karbate impervious graphite heat exchangers that are used for indirect heating of open tanks.

(20) Gear Speed Reducer

Jensen Brothers Manufacturing Company, Coffeyville, Kansas, announces the availability of a planetary gear speed reducer. The unit, named the GeartorK, consists of a system of planetary gears mounted in a frame. The electric motor is bolted directly to this frame.

The GeartorK is available in a variety of sizes from ½ to 10 hp. Same sizes are available with double reduction gear trains.

"KILLER" SHALE SAYS:

AND STAY AWAY FROM ANY WELL WITH A THOMPSON SHALE SEPARATOR! YOU WON'T HAVE A CHANCE!

Shale and abrasives don't have a chance to chew up expensive drilling equipment when drilling mud is conditioned with a Thompson Shale Separator . . . *only clean mud* goes back into the well. If you are drilling deep, you'll want the Thompson "DWF," capable of handling maximum flow from the biggest mud pumps now in operation. Two other models available for shallow and medium depth wells. Attached SAMPLE MACHINE provides accurate foot-by-foot samples of cuttings.

For complete data and specifications on all Thompson models, write today for free illustrated folder.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

KEEPS DRILLING MUD CLEAN — PROVIDES *TRUE SAMPLES* OF CUTTINGS

(21) Generator Set

The Murphy Diesel Company's line of diesel-electric generator sets was recenetly expanded to 11 models ranging from 60 to 133 kw. All models comprise Murphy diesel engines and generators engineered as complete integral units and permanently aligned at the factory, Milwaukee, Wisconsin.

Design features of the engines include "true" diesel operation, unit fuel injection, 4 valves per cylinder, heavy chankshaft with large bearings, oil cooled pistons, and others. Sudden load changes are accommodated by a micro-control hydraulic governor, which maintains desired frequency and voltage with high accuracy.

(22) Fuel Oil Treatment

The American Sand-Banum Company, New York City, has developed a new homegenizing fuel oil treatment, called Sabanol. According to the company, Sabanol disperses sludge and water in the oil, holding in suspension for intensive atomization and maximum burnability. It provides colloidal homogenization of sludge and emulsification of water in all grades of fuel oil.

Claimed to contain a soot retardant and rust inhibitor, Sabanol is a neutral, concentrated, liquid fuel oil treatment, which, it is stated, is free of abrasives, benzene, petroleum solvents, alcohol, ether, carbon tetrachloride, or any other chlorinated solvents.

(23) Coupling Selector

A handy new Flange and Coupling Selector, designed by Nooter Corporation of St. Louis, Missouri, is now available upon request to all engineering personnel. This selector is a tool for engineers and draftsmen who must work with pipe and pipe connections. The slide rule presents at once all pertinent data for 150 lb and 300 lb ASA Standard as well as for 3000 and 6000-lb coupling.

An easily read table also shows wall thicknesses of standard, extra heavy, and double extra heavy pipe as well as for all schedules of pipe from 10 through 160.

(24) Valve Seat Insert

A new valve seat insert is announced by Martin Wells of Los Angeles, California, to meet all size specifications for internal combustion engines.

The manufacturer states that the alloy used in manufacturing this valve seat has been so formulated as to be free from checking and burning under extreme temperatures. Due to the density of this material, these seats have the faculty of dissipating the heat trapped in the valve and materially reduce valve temperatures.

(25) Steam Cleaner

The development of the Super-Duty Hypressure Jenny steam cleaner has been announced by Hypressure Jenny Division, Homestead Valve Manufacturing Company, Coraopolis, Pennsylvania. As a steam cleaner, Super-Duty Hypressure Jenny is said to clean grease, grime, and dirt from machinery and equipment 48 to 60 times faster than by hand methods; and even six times faster than any extra-heavy-duty steam cleaner. Its 300 gal per hour capacity will operate from one to four cleaning guns. Full operating pressure is reached within two minutes from a cold start, the company claims.

Super-Duty Hypressure Jenny is made in trailer mounted, portable, and stationary models. Standard equipment on all models includes one ½ in. hypower cleaning gun, one 25 ft length each of ½ in. and ¾ in. vapor hose, and a choice of either gasoline engine or one-horsepower electric motor.

(26) Relay Systems

Research laboratories for Motorola, Inc., Chicago, Illinois, are introducing a new line of microwave relay equipment to the communications industry. The new equipment provides multiplexed radio channels capable of transmitting and receiving telephone, telegraph, teletype, telemetering, and supervisory control signals over a cross-country microwave relay circuit. The basic system is designed to operate on any one of the 15 channels allocated in the 6575-6875 mc band.

The Motorala microwave systems feature double FM sub-carrier type multiplexing, passive flat reflector antenna systems with all electrical components including the complete RF assembly installed at ground level, and built-in test equipment and terminal facilities for telephone, teletype, telegraph, telemetering, and supervisory control circuits.

(27) Water Softener

A new unit for softening water, combining the advantage of both hot and zeolite processes for water treating, has been announced by Cochrane Corporation, Philadelphia, Pa.

In this hot process zeolite water conditioner the zeolite is the second stage. The first stage precipitates the bicarbonates and the magnesium. The salt-regenerated zeolite removes the remainder of the hardness. This new plan is made possible by the fact that the new high temperature-resistant resins are employed as zeolite, resins that will handle both the high temperatures and the pH values found in the effluent water from the first stage; zeolites employed earlier have been disintegrated by temperatures above 120 F.

(28) Hand Threader

A new hand threading tool for use with "Karbate" impervious graphite pipe has been announced by National Carbon Division, Union Carbide and Carbon Corporation, New York City. The new tool makes it possible to cut, thread, and install pipe on the job. The hand threader cuts "Karbate" impervious graphite like wood, producing clean, sharp threads, the manufacturer claims.

(29) Motor Cooling

The Elliott Company, Jeannette, Pennsylvania, has introduced a new method for cooling large enclosed motors. Situated at the top of the Elliott Unit-Cool'd design is a finned tube air-to-air heat exchanger, comprising a single rectangular unit. A fan draws cooling air from outside the motor, through the tubes, and out the front of the motor enclosure. Air within the motor is passed over the finned tubes, cooled and recirculated.

For cleaning or inspection, removal of a single face plate exposes all cooling tubes and a wire brush or tube cleaner can be passed through.

NELSON CHEMICAL PROPORTIONING PUMPS

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- Wide Volume and Pressure Range
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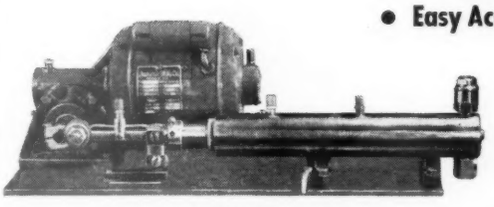
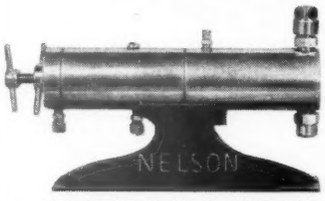
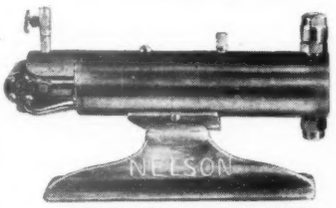


NELSON MOTORIZED DRIVE PUMP



NELSON SYNCHRONIZED DRIVE PUMP



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For Accurate chemical proportioning in the petroleum industry you'll find the efficient answer in a Nelson pump. If a standard Nelson pump doesn't meet your requirements we'll solve your problem with a special job-designed unit. For gasoline gum inhibiting, acid and sludge prevention, treating of emulsions—and for other applications where proportioning or sampling of liquid or chemical solutions is desirable—Nelson chemical proportioning pumps are ideally suited. They were pioneered in oil fields and refineries of Wyoming.

Write for descriptive folder.

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(30) Process Pumps

A new bulletin W-341-B14 on Type HM process pumps has been published by Worthington Pump and Machinery Corporation, Harrison, New Jersey. This vertically-split, single stage, volute centrifugal process pump is pictured in a 4-page bulletin that includes sectional drawings. A versatile pump, it is designed for process work in the chemical, paper, petroleum, and allied industries. It is capable of pressures up to 450 psi, will withstand temperatures up to 500 F, and will take corrosive and non-corrosive liquids, states the manufacturer.

(31) Price Catalog

A descriptive price catalog for Red Devil valve seat pullers for slush pumps has been issued by Oil Well Manufacturing Corporation, Los Angeles, California. This catalog, known as P-111, contains cutaway diagrams, explanations, sizes, dimensions, and completep rices on valve seat pullers and parts for practically all makes of slush pumps in use today.

(32) Pipe Fittings

The Kennedy Valve Manufacturing Company offers the new Bulletin 104, which describes the complete line of Kennedy cast iron, malleable, and bronze fittings. It covers the recent additions of cast-iron screwed, flanged, sprinkler, and extra-heavy malleable fittings to the line, which make it one of the most complete and extensive in the industry.

(33) Metering Element

The Foster flow tube, a new development in primary elements for the measurement and control of fluid flow, is fully described in Foster Engineering Company's new 4-page bulletin. This new flow tube is essentially a differential producer that can be used with properly calibrated conventional recording, indicating, integrating, or control instruments, the company states.

The device consists of a short spool piece with an inner sleeve equipped with two groups of pressure nozzles, one set pointing upstream and the other downstream. These nozzle groups are interconnected by common pressure rings from which connections are made to the meter.

(34) Liquid Line Filter

Marvel Engineering Company, Chicago, Illinois, has issued a 4-page folder on the Marvel synclinal filter, which is now available in housings for line installations.

Marvel liquid line filters are installed in low pressure pipe lines to filter oil or other non-corrosive liquids, where it is imperative that foreign matter be filtered out, such as all types of circulating and lubricating systems.

Graduated sizes and choices of meshes are available to fit specific jobs, where capacity above a single unit is needed a multiple installation can be used. Except for gaskets, all parts are made of metal to assure a strong and serviceable unit. The outer shell is made of steel.

(35) Three Dipropionitriles

American Cyanamid Company, New York City, has recently published a technical bulletin covering three dipropionitriles, which have been made available by the company. They are B,B'-oxydipropionitrile, B,B'-thiodipropionitrile, and B,B'-iminodipropionitrile. These compounds, although excellent solvents for most organic compounds, are immiscible with aliphatic hydrocarbons and possess an unusual selectivity for aromatic compounds.

The selectivity is demonstrated by the extraction of benzene of better than 90 per cent purity from a mixture with benzene. Such separations as that of monomethylaniline from dimethylaniline, extremely difficult by other methods, may be successfully carried out using any of these three compounds, the company claims.

(36) Reference Chart

A new rope reference chart has been designed and produced by New Bedford Cordage Company, New Bedford, Massachusetts, which gives specifications on manila, nylon, and sisal ropes.

This wall chart measuring 17 by 22 in. is attractively designed. Such data as rope diameter, circumference, approximate net weight of 100 ft, approximate gross weight full coils, breaking strength, and working strength is included for sizes ranging from $\frac{3}{16}$ to $3\frac{3}{4}$ in. in diameter.

(37) High Nickel Alloys

Two new technical bulletins on the properties of high nickel alloys have been issued by The International Nickel Company, Inc. Both are 24 pages in length and contain charts, tables on compositions and properties, working instructions, etc.

Technical Bulletin T-7, one of the two, is entitled, 'Engineering Properties of Inconel." In addition to information on Inconel, it contains material on Inconel "X", one of the newer age-hardenable Inco nickel alloys. The second publication is Technical Bulletin T-9 and deals with the engineering properties of "K" Monel and "KR" Monel.

(38) Equipment Catalog

McNally Pittsburg's Catalog 550 carefully itemizes babbitted journal boxes, roller bearing pillow blocks, centrifugal slurry pumps, water valves, conveyor takeups, roller holdbacks, and perforated steel screen plates. Also included is specification information on conveyor and drive pulleys, V-belt sheaves, gears, sprockets, shafts, and keys.

(39) Diesel Engine

Publication of a new bulletin describing and illustrating the Nordberg 4-cycle, 16 in. duafuel diesel engine is announced by Nordberg Manufacturing Company, Milwaukee 7, Wisconsin.

This engine, Type FSG-16, is built in supercharged or non-supercharged units from 5 to 8 cylinders with a 16 in. bore and 22 in. stroke. The horsepower range at an operating speed of 327 rpm is from 730 hp for the five cylinder non-supercharged engine to 1750 hp for the eight cylinder supercharged unit.

Bulletin 177 illustrates various power applications of this duafuel engine that operates on gas fuel with pilot oil, on oil fuel, or on intermediate proportions of either fuel. The engine is also adaptable for operation on sewage or low heat value gases.

(40) Casing Scraper

A new brochure has been issued by Baker Oil Tools, Inc., describing the design and function of two different types of casing scraper. A vertical blade type is recommended for use when the rotary rig still is up, and only hardened cement or a limited number of gunshot burrs are to be removed. It is usually run first above the bit while drilling out cement, and is designed to remove protruding burrs as well as the thin sheath of cement invariably left even after the maximum gage bit has been used for drilling out.

(41) Laminated Panels

An illustrated 12-page booklet giving complete details of a new laminated panel designed to provide efficient, permanent curtain walls or interior partitions, is being offered by the Kaylo Division of Owens-Illinois Glass Company.

The booklet describes Kaylo laminated panels a "sandwich" product 2 in. thick with faces of cement-asbestos board and an inorganic core of Kaylo Insulation. In addition they are available with wood veneer, and metal facings. Each standard 4 by 8 ft Kaylo laminated panel provides a complete wall section, 32 sq ft in area, weighing only about 200 lb which makes for speed of erection, the booklet points out.

(42) Flow Instruments

A complete new 28-page illustrated catalog describing new developments in exhibiting and controlling flow instruments for all industries, has just been published by Fischer and Porter Company, Hatboro, Pennsylvania.

The basic Fischer and Porter devices for coupling a primary metering element to a secondary or exhibiting instrument are discussed in this catalog along with the "Magnabond" magnetic clutch and the electric impedance bridge transmitting systems. The exhibiting instruments illustrated and described are, flow indicators, recorders, integrators and a new pneumatic controller unit.

(43) Electrical Connectors

Mines Equipment Division of the Joy Manufacturing Company, Pittsburgh, Pennsylvania, announces the availability of a new 8-page, 2-color Bulletin No. MC-108-2. This booklet illustrates and describes the company's standard line of molded neoprene rubber electrical connectors and associate equipment such as lamp sockets, distribution centers, and vulcanizers.

(44) Trenches

A 12-page catalog describing the Parsons Model 310 Trenchliner and illustrating its extra large work capacity features is available for general distribution. Trenchliners are designed and produced in five sizes by the Parsons Company to excavate trenches from 5 in. to 6 ft wide. Situated in Newton, Iowa, Parsons is a subsidiary of the Koehring Company of Milwaukee, Wisconsin.

Digging 17 ft deep and 1½ to 6 ft wide in a range of 16 to 21 cutting widths, more than 50 photographs in the new catalog describe the high capacity production features incorporated in the 310 Trenchliner. The bulletin also points out how this Parsons Trenchliner, equipped with a range of 45 digging feeds, will operate under any working condition. Digging feeds range from 8 in. to 15½ ft, moving from 1½ to 3½ cu yd per minute.

(45) Check, Plug Valves

Falcon Products, Inc., Pomona, California, has published a new 12-page colored catalog featuring every current model of Falcon-Greenwood valve; the vertical swing check, the triple action safety quick closing, and the combination check and plug valve.

Complete specifications, prices and installation recommendations are included.

(46) Fire-Proof Door

A colorful and informative 4-page brochure describing a new wood-faced fireproof door is now available from the Kaylo Division, Owens-Illinois Glass Company, Toledo 1, Ohio, manufacturer of the door.

The Kaylo Firedoor has a fire rating for Class B and C openings from Underwriters' Laboratories, official testing agency of the National Board of Fire Underwriters. The unique feature of this door, the company claims, is its inorganic Kaylo core that does not burn, is rot and vermin-proof, and affords exceptional dimensional stability even in extremes of climate.

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SPECIALIZED INDUSTRIAL CLEANING
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(47) Water Treatment

Prevention of lime scale deposition by "threshold treatment" of the water with Calgon is described in a new folder offered by the manufacturer, Calgon, Inc., Pittsburgh, Pennsylvania. Calgon, a vitreous sodium phosphate, is dissolved and the solution is added continuously to the water, effective concentrations ranging from about 1 to 10 parts Calgon per million of water.

Slightly higher concentrations have proved effective, it is added, in eliminating deposition of other scale-forming salts such as calcium sulfate, calcium sulfite, and various salts of barium, as well as calcium carbonate. Typical applications of threshold treatments are cited.

(48) Pumping Unit

A new catalog, published by Lacy Oil Tool Company, is now available. It describes and illustrates in detail the principle of the Lacy air balanced pumping unit. Included is a wide variety of installation photos together with operating characteristics of the unit.

Comparative dynagraph cards showing relative polished rod load ratings help to explain the air balance system of the pumping jack as employed by Lacy. Catalogs obtainable from Lacy Oil Tool Company.

(49) Water Heaters

Patterson-Kelley Company, Inc., 19 Wilson Avenue, East Stroudsburg, Pennsylvania, has published a two-color, 38-page bulletin on instantaneous hot water heaters and heat exchangers. Included are capacity tables based on forced circulation with the water to be heated having a definite pressure to circulate the water through the heater. Water chambers are furnished in 2, 4, or 6 pass construction, depending upon the operating conditions.

(50 Insulation Protection

Literature is available on a new type of insulation protection tradenamed Overkote, marketed by Aber Company, Inc., Houston, Texas. The material is compounded for use as a final weatherproofing and protective coating on insulation used on such equipment as chillers, topping units, storage tanks, ells, valves, and various vessels utilized in the chemical and refinery fields.

It is adaptable whether installations are hot or cold. The product is readily trowelable, furnishes a tough, long lasting coat when dry. According to the manufacturer, it offers greater adhesion, less shrinkage, and shows minimum effect from both extreme temperatures and weather.

(51) Service Pumps

Layne and Bowler, Inc., Memphis, Tennessee, has recently published a 16-page booklet on its close coupled service pumps. Photographs, cross-section diagrams, and explanations make up the bulletin.

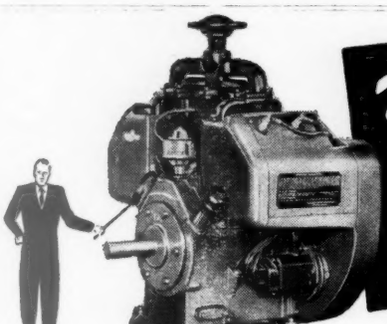
Motor driven pumps, the company states, may be equipped with automatic or remote control for starting and stopping and with automatic solenoid actuated lubrication. Only one adjustment is necessary and it's made as the surface is installed.

Lane short coupled pumps are available in capacities ranging from 50 gal to 20,000 gal a min delivered against any head.

(52) Protective Coating

Bitucote Products, a division of Bridges Paving Company, St. Louis, Missouri, has made available an attractive, 2-color bulletin on the characteristics, uses, and actual applications of Bitucote protective coating—a general purpose emulsified asphalt used for protecting a great variety of structures.

This new bulletin illustrates 8 actual uses of Bitucote protective coating where its resistance to acids, fumes, alkalies, salt spray, brine drip, actinic rays of the sun and the elements was a prime consideration.



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1. V-type design provides a more compact power package for easier, more adaptable installation on original equipment.
2. V-type design means lighter weight, adding to ease of handling and mobility.
3. V-type design provides most efficient air cooling — the air blast travels only half as far as required for a 4-cylinder "straight-in-line" engine.
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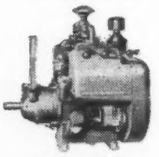
Wisconsin V-type 4-cylinder design is typical of the advanced engineering know-how that goes into all Wisconsin Engines . . . 4-cycle single cylinder, 2-cylinder and 4-cylinder models, in a complete power range from 3 to 30 hp. Write for detailed data.

V VE-4

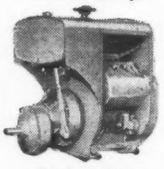
15 to 21.5 hp.

V VF-4



17.5 to 25 hp.

V VP-4



26.8 to 31 hp.

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HOLDS IN SUSPENSION
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Guaranteed Harmless to Personnel and Equipment
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Natural Gas Economics, *by Joseph A. Kornfeld. The Transportation Press, P.O. Box 381, Dallas, Texas. Pages, 261. Price, $5.*

This book presents a study of the principal economic problems facing the nation's natural gas industry. Finance is treated from the standpoints of security issues, construction expenditures, and financial statement analysis with case histories illustrating the financing of several types of expansion and construction. Various kinds of underground storage and their relative cost of construction and operation are discussed, along with a detailed development of reserves, production, and demand. In the chapter on transportation, recent trends in pipe line construction, and the basic economic principles governing the selection of natural gas pipe lines, are outlined.

ASTM Standards on Petroleum Products and Lubricants, *prepared by ASTM Committee D-2, American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Pages, 1422. Price, $5.50 (paper binding), $6.15, cloth binding.*

This publication lists the various ASTM standard and tentative methods of test and specifications pertaining to petroleum, and the regulations and personnel of Committee D-2 and its subcommittees and technical committees. Included also as information only are 10 proposed methods of test, which are published in draft form for the purpose of soliciting comments. Such methods have not been formally approved by the Society, and are distinguished from the standards and tentatives by the absence of an ASTM serial designation.

Geologia de Mexico, *by Ing. Valentin R. Garfias, Ing. Theodore G. Chapin. Editorial Jus, Mexico. Pages, 202. Price, $2.05.*

Written in Spanish, this paper bound book summarizes and brings up to date the geology of Mexico. It includes a nearly complete bibliography, maps, graphics, and cross-sections in folded inserts. The two authors have been in some phase of geology for a number of years. Garfias is a former professor of petroleum engineering at Sanford University, and for several years was in charge of foreign operations of Cities Service Company. Chapin is a former chief geologist of the United States Geological Survey in Alaska, and for over 20 years chief geologist of the Cities Service interests in Mexico.

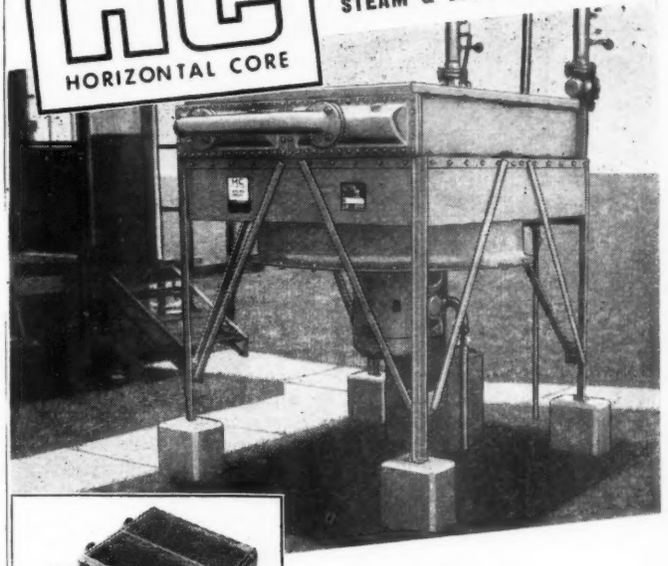
First Annual Institute on Oil and Gas Law, *Southwestern Legal Foundation, Matthew Bender and Company, Inc., 149 Broadway, New York 6, New York. Pages, 623. Price, $16.50.*

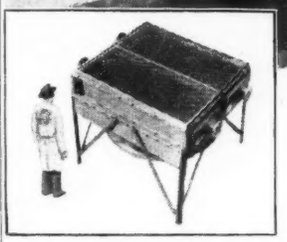
Included in this publication are the papers presented at the first Oil and Gas Institute held last year. The progress of the oil industry constantly opens up or exposes legal areas and problems requiring definitive discussion, states Wallace Hawkins, president of the Magnolia Petroleum Company. And this book, Hawkins adds, is the product of the Institute's careful selection of topics designed to cover such larger problems at a regional or industry level.

Important present-day problems of the oil and gas industry are discussed by a group of lawyers who are acknowledged authorities on specific phases of oil and gas law and taxation as it affects the oil and gas industry.

YOUNG "HC" HORIZONTAL CORE

ECONOMY PLUS VERSATILITY IN WATER, OIL, GAS COOLING... STEAM & VAPOR CONDENSING





Basic "HC" Unit may be used in multiples for greater cooling capacity or combination of services.

IMPORTANT FACTS ABOUT THE "HC"

- LOW COST—small initial investment, economical maintenance.
- VERTICAL AIR DISCHARGE—eliminates cross wind effects.
- HIGHLY EFFICIENT—airfoil section fan.
- MULTIPLE INSTALLATIONS—provide greater capacity, combined services.
- NO VIBRATION—adjustable pitch fan mounted separately from unit.
- LARGE CAPACITY—water cooling, from 600,000 Btu/hr up; oil cooling, from 20,000 Btu/hr up.
- LOW HP REQUIREMENT—1 to 10 hp per fan.
- EASY INSTALLATION—simplified piping and frame construction.
- CORE GUARD SCREEN—protects cores from falling objects.

• Here is another development by Young providing high efficiency cooling and condensing at low initial and operating costs. The Dual coil "HC" is designed for water and lube oil cooling. Manifolds are available for all types of coils. Four sizes, with 2, 4, 6 and 8 coil installations, provide exceptional versatility in heat transfer service. The 4 or 6 blade fan, serving each two coil unit, may be mounted directly on the fan motor shaft, or powered by a V-belt or gear speed reducer drive. Full details about the new "HC" Units, or other Young Heat Transfer Products, are available on request.

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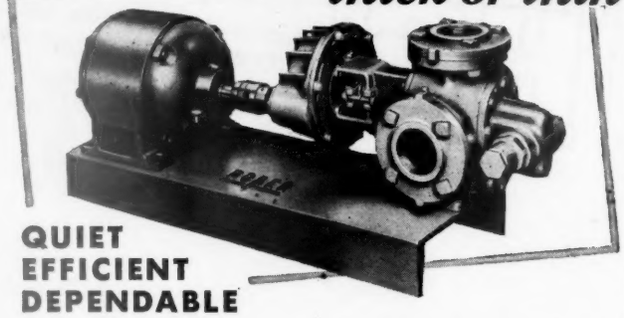
PUMPS for CLEAN LIQUIDS *thick or thin*



QUIET
EFFICIENT
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This Roper 3600 Series Pump is a motor-driven unit with totally enclosed anti-friction gear reduction, mounted on a steel bedplate. Furnished with or ready to receive a standard motor. Capacities from 40 to 100 g.p.m. Other models in double and multiple units also available. Roper motor-driven pumps are highly efficient for pumping oils, greases, solvents, thinners, paints, syrups, etc. in industrial plants and process industries. They handle a wide range of thick or thin clean liquids efficiently, quietly, economically.

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▸ **Engineering Papers of Hydraulic Institute,** *Vol. 2. Hydraulic Institute, 90 West Street, New York 6, New York. Pages, 61. Price, $2.*

This publication includes four papers that have won various engineering contests sponsored by the Hydraulic Institute for the employees of its members in the many phases of the pump industry. The four sections deal with cavitation in centrifugal pumps, centrifugal pumps in the process industries, operation of centrifugal boiler feed pumps, and submergence for centrifugal condensate pumps.

▸ **Gas Transportation System Calculations,** *by Benjamin Miller. Moore Publishing Company, Inc., 9 East 38th Street, New York 16, New York. Pages, 226. Price, $7.50.*

This book is made up of a series of 40 articles appearing in *Gas Age* during 1947 and 1948. The articles, prepared under the title, "Gas Transportation System Calculations," have been altered only slightly. A table of contents, lists of tables, figures and formulas, and a preface have been added.

▸ **Combined Social Security and Withholding Tax Chart,** *Delbridge Calculating Systems, Inc., St. Louis, Missouri. Pages, 34. Price, $7.50 (Monthly Payroll Period, $10.)*

Employers can now combine social security and withholding taxes in one item instead of making two separate deductions. The Delbridge chart shows the amount of the new 1½ per cent FICA deduction, the amount of income tax to be withheld, and the combined amount of the two tax deductions. It also shows the special 15 per cent deductions, the daily and miscellaneous payroll period deductions, from one to seven days, as direct answers without the use of multiplication or division.

Use of the chart simplifies the payroll tax deduction record work by recording only the combined amount instead of making two separate tax entries.

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Erie, Pa.—R. J. Maggi, Box 711
Houston—Henry H. Paris Distributor, Inc., Bo 932
Kansas City, Mo.—Wm. J. Hebenstreit, 3122 Coleman Rd.
Los Angeles—James A. Riordan Co., 1400 Santa Fe Ave.
Minneapolis—Lin J. Krause, 200 Lumber Exchange
Newark, N.J.—Murray Eskin, Industrial Office Bldg.
New York—Henry Stein, 50 Cliff St.
Philadelphia—J. W. Worthington, 401 N. Broad St.
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., Mutual Bldg.
San Francisco—Earl H. Jones & Co., 1150 Folsom St.
Seattle—Earl H. Jones & Co., 619 Second Ave.

FACTORY 'PHONE: ELM GROVE 3296

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